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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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☐ *Additional inventors are being named on the ___ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

Drilling/Bolting Machine Having a Manual Operator Input Device with Enable Switch and Related Methods; Drill Head with Internal Sensors;Resin Inserter

CORRESPONDENCE ADDRESS

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☑ Other (specify) POSTCARD

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

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Respectfully submitted,

SIGNATURE ______

Date 7/8/03

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

DRILLING/BOLTING MACHINE HAVING A MANUAL OPERATOR INPUT DEVICE WITH ENABLE SWITCH AND RELATED METHODS

This is a PROVISIONAL application filed under 35 U.S.C. Section 111(b) and in compliance with the requirements of 35 U.S.C. Section 112.

Technical Field

The present invention relates to the drilling art and, more particularly, to a drilling or bolting machine including a manual operator input device for controlling at least one aspect of the drilling or bolting operation.

Background of the Invention

Drills using rotatable bits for penetrating into the earth are in widespread use. One application of such drills is in conjunction with a machine known in the vernacular as a "roof bolter" capable of both forming boreholes in the faces of the passageways of underground mines and then installing roof anchors or "bolts" in the boreholes. As is well-known in the art, the bolts once installed provide support for the adjacent portion of the mine face (typically the roof and ribs), thereby reducing the incidence of catastrophic cave-ins.

In the typical bolting operation, once the borehole is created using the drill, a resin cartridge is inserted. The drill head is then used to insert a roof bolt into the borehole to rupture the resin cartridge. Once ruptured, the bolt is rotated using the drill head to mix the resin, which is designed to quickly set and form a secure bond with the material surrounding the borehole.

Oftentimes, a manual operator input device, such as a joystick, is used to control the operation of the drill head, both during the drilling and bolting cycles of the operation. A single joystick may be associated with a manual control valve such that movement in a first direction (i.e., forward) results in drill head feed, rotation, or both. Alternatively, two independent joysticks may be used: one for controlling feed and the other, rotation. Using a manual control valve also allows the speed and direction of rotation or feed to be easily controlled by simply pivoting the joystick. However, electronic, solenoid-operated proportional control valves may also be used, if desired.

While an input device such as a joystick provides an intuitive and easy-to-use interface for controlling the drilling and bolt insertion operations, it has been discovered that the operator sometimes inadvertently moves the input device (joystick) for causing rotation when only feed is desired. Likewise, the operator may desire to rotate the chuck at a slow speed to assist in coupling the bolt head with a "pot" in a wrench or socket, but inadvertently moves the joystick to a position such that a higher rotational speed results. Both of these occurrences decrease the efficiency of the operation.

Accordingly, a need is identified for a manual input device for use in controlling a drilling operation, such as for forming boreholes in one or more faces of a passageway in an underground mine. The input device

would be simple to operate using only one hand, yet would prevent inadvertent actuation of the drill head (feed, rotation, or both). The input device would provide failsafe operation and would be tamper-resistant to prevent operator override. The input device would also be easily retrofitted onto existing drilling machines. The use of a neutral switch to prevent movement (tramming) of a drilling machine on power up is also disclosed.

Detailed Description of the Invention

Reference is now made to Figure 1, which schematically depicts a system 10 for manually controlling a drilling operation. In the illustrated embodiment, the system 10 includes a manual operator input device 12, such as a joystick capable of pivoting movement about at least one axis (see Figure 2). As will be understood further upon reviewing the description that follows, the input device 12 controls at least one aspect of the drilling or bolting operation, such as the rotation of the drill head, the feed of the drill head, or the movement (tramming) of the corresponding machine to which the drill head is attached.

The system 10 further includes a controller 14 and an actuator 16 for actuating the drilling and/or bolting operation based on the manual input received, such as by rotating and feeding either a drill steel and bit into the earth to form a borehole or a roof bolt into the borehole once formed. In the illustrated embodiment, the actuator 16 includes separate fluid-operated motive devices or motors 18, 20 for providing the feed and rotational forces to the drill head (not shown). The fluid flow to the motors 18, 20 may be regulated or controlled by a valve package 21 (see Figure 7) associated with manually operated feed and rotation control valve 22 (see Figure 6) also forming part of the actuator 16. The valve 22 may include multiple sections

22a . . . 22n (see Figure 8), each of which may control or regulate the flow of fluid to a single motor. For example, as shown in Figure 1, the control valve 22 may include separate feed and rotation sections 22a, 22b.

A switch 24 is associated with the feed and rotation control sections 22a, 22b of the valve 22 and the controller 14. When open, the switch 24 indicates that the valve 22 (or, more specifically, the spool 23) is in the neutral position. These "neutral" switches 24 may be conventional position or proximity switches, various types of which are well known in the art, and may be positioned adjacent to the valve 22. An exemplary neutral switch 24 including a detent ball 24a seated in a circumferential groove 23a formed in the valve spool 23 of a single valve section 22a is shown in Figure 8. When the ball 24a is moved as the result of the translation of the spool 23 (which may be connected directly to the input device 12), a signal propagates to the controller 14 indicating that the valve 22 (or valve section 22a or 22b) is no longer in the neutral position.

The preferred embodiment of the input device 12 in the form of a joystick 30 is shown in Figure 2. As noted above, the joystick 30 is mounted to a stable support structure (not shown) such that pivoting movement about at least one axis is permitted. The mounting is preferably such that the joystick 30 is normally held at or biased to a neutral position, with movement in two opposite directions overcoming the biasing force and manually opening the control valve 22. The biasing force is preferably such that it may be easily overcome by the operator, but sufficiently high to preclude movement as the result of inadvertent bumping or jarring.

The joystick 30 includes an elongated body or shaft 32 that supports an oversized head 34. The head 34 includes a generally rounded or hemispherical upper portion 34a adapted for being comfortably received in

the cupped hand of the operator, generally in engagement with the palm. A generally tapered or frusto-conical lower portion 34b of the head 34 provides support for the upper portion 34a and serves as the interface with the shaft 32. As a result of the frusto-conical shape, the lower portion 34b provides a flat, slightly recessed resting place for the tips of the operator's fingers when the corresponding hand is positioned adjacent to the joystick 30, such as during manual engagement. The upper and lower portions may be secured together via fasteners F. As shown in Figure 2, the heads of the fasteners F may be recessed in the upper portion 34a to ensure maximum operator comfort.

In accordance with one aspect of the invention, the input device 12 includes an enable switch 36 for preventing inadvertent actuation of the actuator 16 (i.e., the motors 18, 20). In the most preferred embodiment, as shown in Figure 2, the enable switch 36 is normally open and associated with a trigger or button 38 provided on the joystick 30. This positioning is desirable, since it allows the operator to simultaneously engage both structures using a single hand. As also shown in Figure 2, the button 38 may be a low-profile, generally semi-circular piece of material positioned in a slot 37 formed at the interface between the upper portion 34b and the frusto-conical, lower portion 34a of the head 34. In the home position, the button 38 projects from the slot 37. Accordingly, when the operator's hand is resting on or adjacent to the head 34, one or more fingers overlie the button 38 (which as shown in Figure 2 preferably has a rounded face 38a to ensure comfort). This allows for the button 38 to be depressed or engaged in a simple fashion, such as by simply squeezing the head 34 of the joystick 30.

The button 38 is preferably biased toward a non-engaged or home position by a spring or like biasing means (not shown) positioned within the head 34. As is the case with the joystick 30, the biasing force supplied

should be low enough that it is easily overcome by finger action. However, it should not be sufficiently high to prevent inadvertent actuation, such as by being bumped or jarred by the operator or contacted by a falling object.

As briefly noted above, movement of the joystick 30 from a neutral or home position results in the opening of the control valve 22 and the closing of one or both of the neutral switches 24. However, unless the enable switch 36 is closed (such as by depressing the button 38) before the joystick 30 is moved from the neutral position (as determined by the closing of the neutral switch(es) 24), the controller 14 does not actuate (energize) the valve package 21 and, consequently, no flow to the valve 22 results. In other words, if the joystick 30 is moved from the neutral position before the enable switch 36 is closed (i.e., before the button 38 is engaged), the controller 14 does not signal the valve package 21 to allow fluid flow to reach the corresponding valve 22, which means that the feed or rotation motors 18, 20 are not actuated. Likewise, if the enable switch 36 is closed while the joystick 30 is moved from the neutral position, no actuation occurs even if the joystick is returned to the neutral position with the enable switch closed and then moved from the neutral position again with the switch closed. However, the logic arrangement in the controller 14 (see Figures 3 and 5) is such that, once the joystick 30 is moved from the neutral position with the enable switch 36 closed, it thereafter may be opened (such as by releasing the button 38) without incident.

To prevent the operator from defeating the function provided by the enable switch 36 (such as by jamming the button 38 in the engaged position), the system 10 may include a "watchdog" circuit 50 (Figure 1). This circuit 50 checks at a predetermined interval (e.g., every five seconds) to see if the enable switch 36 is open. If the switch 36 is not opened after one or

more of the intervals pass (the number required may be varied), the controller 14 may act to prevent flow to the valve 22.

In accordance with a second aspect of the invention, and as shown in Figure 4, a similar arrangement of neutral switches 24 may also be used in conjunction with a controller 14 and an actuator 16 associated with the valve or valve sections 62, 64 that supply the fluid for operating the hydraulic motor(s) 66, 68 used to move or "tram" the drilling or bolting machine. In this arrangement, the controller 14 prevents the machine from starting or moving until the valve sections 62, 64 are in the neutral position (which is accomplished by moving a corresponding manual input device 12 (i.e., a joystick, lever, or handle) to the neutral position), as determined by the neutral switches 24. This guards against unexpected movement of the machine at power up in the event the input device 12 is not in the neutral position. In other words, if the input device 12 is jammed in a position that would cause movement in the forward direction and an attempt is made to start the machine.

As also shown in Figure 6, an enable switch 36 of the type described above may also be used in conjunction with the neutral switches 24 for preventing a valve package 65 upstream of the valve sections 62, 64 from opening. As above, the enable switch 36 may be associated with the input device 12, preferably on the handle, lever, or joystick used to control the movement (tramming) of the machine. The controller 14 requires the closing of the enable switch 36 when the input device 30 is in a neutral or home position before actuation. The controller 14 also does not signal the valve package 65 to open when the enable switch 36 is closed after the input device 12 is moved from the home or neutral position. However, once the signal is generated to open the valve package 65, the enable switch 36 may be opened

without incident. A watchdog circuit (not shown) similar or identical to the one described above may also form part of the controller for ensuring that the enable switch 36 is not defeated.

Figure 9 illustrates an alternative input device 12 in the form of a lever 30 that may be used to simultaneously control two distinct valve sections 22a, 22b. The lever 30 includes a first linkage 70 extending between a body or shaft 32 and a valve spool 23a associated with a first valve section 22a. A second, generally transverse linkage 72 extends between the body 32 and a post 74. A pivotally mounted connector 76 connects the post 74 to a second valve spool 23b associated with a second valve section 22b. Both the post 74 and lever 30 are mounted using ball joints 78 to permit movement along at least two different axes in the same plane.

As should be appreciated, the input device 12 of this embodiment allows for simultaneous control of two different valve spools 23a, 23b using the same input device 30 (lever). More specifically, the second linkage 72 is rotatable about the shaft 32 such that it moves to and fro when the lever 30 is manipulated (pivoted) to pull the first linkage 72 and open the first valve spool 23a. However, this movement of the lever 30 does not open the second valve spool 23b, since the post 74 simply pivots as a result of the ball joint 78. Movement of the lever 30 to the left causes the connector body 76 to pivot about a pivot point P defined by a clevis 78 connected to a support structure 80, which causes the corresponding valve spool 23b to open. The result is the same even when the lever 30 is first pivoted such that the first valve spool 23a is opened. Pivoting of the lever 30 to the right likewise causes the second valve spool 23b to move to a position such that flow through the corresponding valve section 22b may be reversed. Forward movement of the lever 30 likewise may cause the first valve spool

23a to move to a reverse-flow position, and combined left or right movement results in a corresponding repositioning of the second valve spool 23b.

As should be appreciated, by associating the first valve spool 23a with drill head rotation and the second valve spool 23b with feed, it is possible to commence the former without the latter. However, both feed and rotation may result by pulling the lever 30 back and then moving it to the left. Likewise, rotation and feed can be simultaneously reversed by moving the lever forward and to the right. Other combinations are of course possible in light of the foregoing description. It should be appreciated that, by using neutral switches and providing an enable switch on the input device, this arrangement may also be used in conjunction with the controller 14 to create a lockout condition unless the switches are actuated in a certain sequence, as outlined in detail above.

The foregoing descriptions of various embodiments of the invention are provided for purposes of illustration, and are not intended to be exhaustive or limiting. Modifications or variations are also possible in light of the above teachings. The embodiments described above were chosen to provide the best application to thereby enable one of ordinary skill in the art to utilize the disclosed inventions in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.

RESIN INSERTER

This is a PROVISIONAL application filed under 35 U.S.C. Section 111(b) and in compliance with the requirements of 35 U.S.C. Section 112.

Technical Field

The present inventions relate to the earth drilling or roof bolting arts and, more particularly, to devices for introducing resin into a borehole adapted for receiving an anchor, such as a roof bolt, in an underground passageway.

Background of the Invention

Historically, the most widely used approach for installing a roof bolt in the face (roof or side wall) of a mine passage included the use of an expandable nut on the end of the bolt to engage the side wall of the bore hole and hold the bolt in place. With the development of strong epoxy resins, mine operators began to use a resin cartridge in the distal end of the bore hole to provide additional holding force. As the roof bolt is pushed in the drilled hole and rotated during the installation process, the resin cartridge is ruptured and the catalyst mixes with the epoxy resin to form a hardened, permanent adhesive mass around the expandable nut and the adjacent bolt surface and anchoring against the inside surface of the hole.

In more recent years, as the epoxy resins have been further developed to make them stronger and provide for more rapid hardening, some roof bolt designs have eliminated the expandable nut on the end. Indeed, one of the most popular roof bolts today comprises simply a common reinforcing bar or rebar. The distal end of the rebar engages the resin cartridge in the distal end of the bore hole. As the proximate end of the rebar is engaged and rotated by a socket driven by a spinner, the cartridge ruptures mixing the catalyst with the resin. The mixture rapidly hardens to secure the roof bolt in place.

One area of continuing development with relation to the roof bolting method is the step of insertion of the resin cartridge into the bore hole. Originally, the operator of the roof bolting equipment worked from the mine floor inserting the resin cartridge into the bore hole by hand. In a relatively narrow coal seam mine, where the roof is low, this works reasonably well. However, as the seam thickness increases, and the roof moves up to the eight plus foot mark, the efficiency of the operation falls dramatically. In most instances a ladder is required, which means the process is slower and much more physically demanding.

As described in U.S. Patent No. 5,951,208, the disclosure of which is incorporated herein by reference, the assignee of the present invention previously developed a manual wand including a spring-loaded driver for use in inserting a resin cartridge in a borehole. While this arrangement works quite well for its intended purpose, it like most other prior art approaches requires a separate driver in addition to the drill head for supplying the force for introducing the resin cartridge into the borehole. This increases the complexity of the arrangement and the overall cost of manufacturing and operating the machine.

Accordingly, a need is identified for a resin inserter that eliminates the foregoing limitations and problems.

Detailed Description of the Invention

Reference is now made to Figure 1, which illustrates a drill head D such as for use on a rock drilling/roof bolting machine (not shown). The rock drilling machine may be of the type used for both forming boreholes in the passageways of underground mines and then installing roof bolts in the boreholes to provide support for the adjacent mine face. The drill head 10 includes a body B or case, which may be generally rectangular in shape. A rotatably mounted or supported receiver (chuck) C associated with the body B of the drill head D is adapted for receiving the distal end of an implement. In one possible mode of operation, a wrench or socket is positioned in the chuck C, which in turn receives a drill steel and bit (not shown, but hereinafter collectively referred to as the drill "bit") for penetrating into the earth to form the borehole. The drill bit may be of any known type, and preferably is adapted for drilling narrow width (less than 2") boreholes in rock and like materials. Although the chuck C is shown as having a generally square cross-section in Figure 1, it should be appreciated that other shapes may be used as well (see, e.g. Figure 2), depending on the particular types of wrenches, sockets, or drill bits used.

Feed for the drill head D and hence the bit to form the borehole may be provided by an adjacent linearly reciprocating mast (not shown), which may be of any conventional type (e.g., a mast having sliders, rods, or C-channels along which the drill head translates to-and-fro relative to the face of the mine passage). The mast may be supported by a boom, swing arm, or like structure for use in positioning the drill head D adjacent to the face of the

mine passage. The mast may also include a retractable drill guide (not shown) for selectively receiving guiding the drill bit, a roof bolt, or the inserter of the present invention.

With reference now to Figures 2-3, one embodiment of a resin inserter 10 for use with a drill head D of the type shown in Figure 1 is disclosed. The resin inserter 10 includes a generally hollow or tubular body. In the illustrated embodiment, the body comprises a first elongated tubular portion 12 connected to a second elongated tubular portion 14. A first end of the first portion 12 defines an adaptor 12a for insertion into the chuck C of the drill head D or into a wrench or socket received therein. The cross-sectional shape of the adaptor 12a is preferably a generally regular polygon, such as the hexagon shown in Figure 2a or the square shown in Figure 3. This is preferred to ensure that the inserter 10 is properly seated in the chuck C. However, the adaptor 12a may be of any cross-sectional shape, as long as it can be received by the drill head D such that fluid communication is possible between an opening 12c in the first portion 12 of the resin inserter 10 and a corresponding fluid outlet (not shown) on the drill head (which is typically used for supplying a flow of bailing fluid to a channel formed in the drill bit for flushing away the dust and cuttings created during the drilling process).

A second end of the first portion 12 is adapted for coupling to a corresponding first end 14a of the second portion 14, and thus forms a coupler 12b. In the illustrated embodiment, the section portion 14 is oversized relative to the first portion 12, such that the coupler 12b is received in the corresponding end 14a to establish the connection. To secure the connection, a threaded interface is provided between the two ends 12b, 14a, but the use of other permanent or semi-permanent coupling means (e.g., welding) is possible.

The opposite or second end 14b of the second portion 14 (adjacent the "delivery" end of the inserter 10), is adapted for receiving a cap or gland 16. The gland 16 is slightly oversized in diameter relative to the second portion 14, and includes an opening 16a at one end for receiving and coupling with the second end 14b, such as by threaded engagement or otherwise. As perhaps best understood with reference to Figure 2b, the opposite end of the gland 16 includes an inwardly projecting, generally annular lip 16b, the function of which will be outlined further in the description that follows. The inner diameter of the circle defined by the lip 16b is preferably sized for receiving a rupturable resin container or cartridge R, which is sometimes referred to in the vernacular as a "sausage."

Positioned within the tubular second portion 14 of the inserter 10 is a slidably movable member in the form of a piston or plunger 18. As perhaps best shown in Figure 2b, the plunger 18 includes a head portion 18a having a first engagement surface 18b and an oversized base portion 18c having a second engagement surface 18d generally parallel to and opposite the first engagement surface. Both the head and base portions 18a, 18c are generally cylindrical and thus create a stepped configuration. The base portion 18c is generally sized to fit snugly within the passage defined in the tubular second portion 14 of the inserter 10, while the head portion 18a is sized such that it may pass through the opening in the gland 16 defined by the annular lip 16b. However, the size of the base portion 18c is such that it cannot pass through the opening in the gland 16 (and in fact defines an annular seating surface 18e capable of engaging the inner surface of the annular lip 16b), nor can it enter the passageway formed in the first portion 12 of the inserter 10.

In one possible mode of operation, a resin cartridge R is inserted

through the opening in the gland 16 at the delivery end and into the tubular passageway in the second tubular portion 14 of the inserter 10. The tubular portion 14 with the piston or plunger 18 is preferably sized such that a portion of the resin cartridge R remains exposed at the delivery end of the inserter 10.

A retainer may be placed on the end of the cartridge R to ensure that it is properly retained in the borehole. For example, as shown in Figure 2c, a piece of wire or a pin 20 having a length greater than the diameter of the circle defined by the annular lip 16b (and preferably slightly greater than the borehole) may be passed through the exposed end of the cartridge R. Alternatively, a different type of retainer may be attached to the head end of the cartridge R. The advantage of this arrangement over prior art proposals, including the one disclosed in the '208 patent, is that the need for a special retainer internal to the inserter is eliminated.

If not done already, the inserter 10 may be associated with the drill head D, such as by positioning the first end 12a of the first portion 12 in the chuck C or socket formed therein and associating the opposite end with the drill guide, if present. The drill head D may be manipulated to move the opposite end of the inserter 10 to a position adjacent the borehole (not shown, but see Figure 4b). In this position, the inserter 10 is typically oriented at an angle of 0°-90° relative to the horizontal (depending on the orientation of the borehole, including whether it is formed in a roof or rib portion of the mine passage or formed parallel or at an angle to the horizontal or vertical plane), with gravity or friction serving to keep the plunger 18 and the resin cartridge R in the "home" position as described above.

Once the inserter 10 is in the operative position, the fluid feed F of the drill head D is actuated to supply fluid through the opening 12c (which conveniently is the bailing fluid supplied to the drill bit during the

previous drilling operation) in the corresponding end of the inserter. In the preferred embodiment, the fluid is water W under high pressure, but air or other gases or liquids could also be used. The water W flows through the first portion 12 and engages the surface 18d of the plunger 18. The engagement gently advances the plunger 18 within the corresponding passageway with a sufficient amount of force to advance or push the resin cartridge R (which is only held in place the by external retainer 20 and is thus free to move) through the opening in the gland 16 at the delivery end of the inserter 10 and into the adjacent borehole. Although a portion of the plunger 18 may pass through this opening in the delivery end (and thus help to insure full insertion of the resin cartridge R), the oversized base portion 18c cannot so pass. This means that the plunger 18 is effectively captured in the passageway (and actually guards against any substantial fluid leakage through the opening in the gland 16). The wire or pin used as the retainer 20 is preferably sized such that it drags along the sidewalls of the borehole and thus holds the cartridge R in place.

In either case, once the resin cartridge R is inserted into the borehole to the desired degree (which may be visually observed by the operator, or may be determined by the machine using timers or sensors), the fluid feed F is shut off, and any fluid in the inserter 10 behind the plunger 18 is allowed to drain. The plunger 18 may return to the home position automatically via gravity (but could also be returned by the installation of a subsequent resin cartridge). Typically, the inserter 10 is then removed from the operative position to allow for the installation of the roof bolt (not shown) in the borehole using the drill head D (which ruptures the resin cartridge R and, upon being rotated, mixes the resin to speed the setting time). After a subsequent borehole is drilled, however, the resin insertion sequence

described above may be repeated using the inserter 10.

A second embodiment of a resin inserter 100 is shown in Figures 4-5. In this embodiment, the inserter 100 includes a body comprising a first portion 112 telescopingly received in a second, tubular portion 114. The second portion 114 includes an annular lip 114a, 114b at each end defining an opening at each end. The first portion 112 includes an oversized head 112a, which may be unitary or defined by a separate washer having a diameter greater than the second portion and held in place using a fastener such as a bolt. Although capable of moving to and fro, the first portion 112 is thus effectively connected to the second portion 114.

At a first end of the first portion 112 of the body of the inserter 100, an oversized adaptor 112b is provided. The adaptor 112b is adapted for insertion in the chuck C or socket of the drill head D, and is generally oversized such that it is prevented from passing through the opening defined by the annular lip 114b (which may be unitary or defined by a separate component fastened to the second portion 114). The distance D_1 from the end of the adaptor 112b closest to the second portion 114 of the body to the oversized head is preferably at least as great as the distance D_2 from the inside surface of annular lip 114b to the inside surface of annular lip 114a. This ensures that the first portion 112 (which is effectively a piston) can travel or "stroke" the complete length of the second portion 114 (which is effectively a cylinder for receiving the piston) when the inserter 100 is compressed.

In operation, the resin cartridge R may first be inserted in the tubular second portion 114 through the opening adjacent the annular lip114a at the delivery end. As described above, the cartridge R may include an external retainer 120, such as a pin or piece of wire, for engaging the borehole H. The inserter 100 is then positioned with the adaptor 112b in the chuck C

or socket of the drill head D and the opposite end in any drill guide or like structure present. The opposite end of the inserter 100 is then positioned adjacent to the entrance E of the borehole H. Alternatively, the exposed end of the cartridge R may be inserted into the borehole H and then the inserter 100 associated with the drill head D.

Once in position, the feed of the drill head D is used to stroke the first portion 112 or "piston" forming part of the body of the inserter 100 (see Figure 5 and note the fully extended and fully compressed positions). The oversized head 112a thus engages the adjacent end of the resin cartridge R and drives or pushes it through the tubular passageway (which is typically aligned with the direction of gravity) and out the delivery end of the inserter 100. The cartridge R is thus introduced into the borehole H (with the external retainer 120 frictionally engaging the sidewalls and providing a holding function; note Figure 4b), at which point the drill head feed may be reversed to draw the inserter 100 away from the entrance E. The inserter 100 is then removed from the drill head D and the roof bolt or other anchor may be inserted in the chuck C or socket. The drill head feed is then used to install the bolt or anchor in the borehole H, which ruptures the resin cartridge. The bolt or anchor may then be spun using the drill head D to mix the resin, which upon setting will provide the desired roof support.

The foregoing descriptions of various embodiments of the invention are provided for purposes of illustration, and are not intended to be exhaustive or limiting. Modifications or variations are also possible in light of the above teachings. For example, the inserter 10 of the first embodiment may be formed as a single unitary component. The embodiments described above were chosen to provide the best application to thereby enable one of ordinary skill in the art to utilize the disclosed inventions in various

embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.

In the Claims

1. An inserter for inserting a resin cartridge in a borehole using a drill head having a chuck or socket associated with a fluid feed, comprising:

an elongated body including a first end adapted for insertion in the chuck or socket in communication with the fluid feed, a second, tubular end adapted for receiving the resin cartridge, and a piston slidably positioned within the tubular end for driving the resin cartridge at least partially into the borehole, including when the fluid feed is activated.

2. The inserter according to claim 1, wherein the tubular body includes a gland having an annular lip defining an opening for receiving the resin cartridge.

3. The inserter according to claim 2, wherein the piston is stepped and includes a head sized for passing through the opening in the gland and an oversized base.

4. The inserter according to claim 1, wherein the body is formed of at least two elongated, interconnected tubular portions, wherein the piston is positioned for movement in only one of the tubular portions.

5. The inserter according to claim 1, wherein the first end includes an adaptor for mating with the chuck or socket and forms part of the piston.

6. A bolting machine including the drill head and inserter of claim 1.

7. An inserter for inserting a resin cartridge in a borehole using a drill head having a chuck or socket, comprising:

an elongated body including a first end adapted for insertion in the chuck or socket and a second end adapted for receiving the resin cartridge;

wherein the first end is provided on a first portion of the body telescopingly received in an opening defined by an annular lip in a second, tubular portion in which the second end for receiving the resin cartridge is formed.

8. The inserter according to claim 7, wherein the first end includes an oversized adaptor having a square or polygonal cross-section.

9. The inserter according to claim 7, wherein the first portion of the body includes an oversized head adapted for engaging an inner surface of the annular lip.

10. A bolting machine including a drill head for receiving the inserter of claim 7.

11. A method of installing a bolt or anchor using a drill head having a fluid feed associated with a socket for receiving the drill bit, comprising:

drilling a bore hole having an entrance using the drill bit received in the socket of the drill head;

loading a rupturable resin cartridge in a tubular inserter having a delivery end;

placing the inserter in the socket of the drill head with the

delivery end adjacent the entrance;

pushing the cartridge from the delivery end of the inserter through the entrance and into the bore hole using the fluid feed;

inserting a roof bolt into the bore hole rupturing said cartridge and setting the roof bolt in place.

12. The method of claim 11, further including the step of providing a plunger in the tubular inserter, wherein the plunger is actuated by the fluid feed to push the resin cartridge through the delivery end of the inserter.

13. The method of claim 11, wherein step of using the fluid feed comprises supplying a flow of water to the inserter.

14. The method of claim 11, further including the step of associating a wire, pin, or other retainer with an end of the resin cartridge projecting through the delivery end of the inserter.

15. A method of installing a bolt or anchor using a drill head having a socket for receiving the drill bit, comprising:

drilling a bore hole having an entrance using the drill bit received in the socket of the drill head;

loading a rupturable resin cartridge in a tubular portion of an inserter having a delivery end, the inserter further including a piston capable of telescoping in the tubular portion of the inserter;

placing the inserter in the socket of the drill head with the delivery end adjacent the entrance;

using the drill feed to cause the piston to push the resin cartridge

through the delivery end of the inserter through the entrance and into the bore hole;

inserting a roof bolt into the bore hole rupturing said cartridge and setting the roof bolt in place.

16. The method of claim 15, further including the step of associating a wire, pin, or other retainer with an end of the resin cartridge projecting through the delivery end of the inserter.

17. A resin cartridge for installation in a borehole comprising a body having a first end including a transversely extending wire or pin, whereby the wire or pin is slightly greater in length than the diameter of the borehole such that the ends of the wire or pin drag along or engage the borehole during insertion of the cartridge and provide a holding function.

18. The resin cartridge of claim 17 in combination with the inserter of claim 1 or claim 7, wherein the wire or pin is external to the inserter at all times.

19. A method of installing a bolt or anchor using a drill head having a socket for receiving the drill bit, comprising:

drilling a bore hole having an entrance using the drill bit received in the socket of the drill head;

loading a rupturable resin cartridge in a tubular portion of an inserter having a delivery end;

inserting a pin or wire having a length greater than a diameter of the borehole transversely through one end of the resin cartridge;

placing the inserter in the socket of the drill head with the delivery end adjacent the entrance;

pushing the resin cartridge through the delivery end of the inserter through the entrance and into the bore hole;

inserting a roof bolt into the bore hole rupturing said cartridge and setting the roof bolt in place.

20. The method of claim 19, wherein the inserting step is completed before the loading step and the end of the resin cartridge including the pin or wire remains external to the inserter.

DRILL HEAD WITH INTERNAL SENSORS

This is a PROVISIONAL application filed under 35 U.S.C. Section 111(b) and in compliance with the requirements of 35 U.S.C. Section 112.

Technical Field

The present invention relates to the drilling art and, more particularly, to an instrumented drill head for intended use in drilling boreholes or in installing roof anchors or bolts in the boreholes once formed.

Background of the Invention

Heavy-duty drills using rotatable bits for penetrating into the earth are in widespread use. Recently, significant attention has been given to the use of feedback control to make the drilling operation more efficient, especially in the case where the material being drilled is hard (e.g., rock). By using such feedback control, the drilling operation can be continuously monitored and adjusted to ensure that the correct amount of thrust is applied or the rotational speed of the drill bit is maintained at the most efficient level to maximize the amount of material removed per revolution, to avoid unnecessary grinding of the material, and to extend the service life of the bit. Examples of such feedback control systems can be found in commonly assigned U.S. Patent No. 6,216,800 and U.S. Published Patent Application

No. 2001/0050186, the disclosures of which are incorporated herein by reference. As an adjunct to measuring the thrust force and rotational speed, the torque acting on the drill bit can also be estimated and used to prevent overloading on the rotational motor.

One manner of assessing the thrust acting on the drill bit and the rotational speed is by measuring characteristics of the hydraulic fluid used to power the drill. For example, the pressure in the fluid may be measured by a sensor (transducer) to obtain a signal proportional to the amount of thrust acting on the drill bit. Likewise, the velocity of the hydraulic fluid flowing to the motor for rotating the bit may be measured using a sensor to obtain a signal proportional to the rotational speed. One or both of these "feedback" signals may then be used to monitor the drilling operation and make any adjustments necessary to maximize efficiency and extend the life of the drill bit.

In the past, the feed pressure and velocity sensors associated with the lines supplying hydraulic fluid to the drill head were "hardwired" to an input board used to transmit the output signals over wires connected to a remote controller or computer located elsewhere on the corresponding drilling machine for providing the desirable feedback control. In the harsh environment where earth drilling usually takes place (including in underground mines), the wiring is susceptible to being damaged. Even a minor amount of damage can render the feedback control totally useless. When using transducer types of sensors, consideration must also be given to hose losses, temperature, and inefficiency, all of which are difficult to predict with any certainty. This can lead to inaccurate readings that render the feedback control system only marginally effective at best.

A more conventional manner of measuring the rotational speed

is to employ sensors mounted external on the drill head adjacent to the bit to physically measure the rotational speed or the thrust acting on it. However, such sensors must be calibrated frequently to compensate for machine variances. Like the fluid pressure and velocity sensors mentioned in the foregoing discussion, the external sensors are also susceptible to being damaged as the result of the conditions under which the drilling machine is typically used.

Accordingly, a need is identified for an instrumented drill head that eliminates the foregoing limitations and problems.

Detailed Description of the Invention

Reference is now made to Figure 1, which illustrates a drill head 10 such as for use on a rock drilling machine (not shown). The rock drilling machine may be of the type used for both forming boreholes in the passageways of underground mines and then installing roof bolts in the boreholes to provide support for the adjacent mine face. The drill head 10 includes a body or case 11 having an interior I (and thus defining an exterior E; see Figure 2). A rotatably mounted or supported receiver (chuck) 12 associated with the body or case 11 of the drill head 10 is adapted for receiving the distal end of a wrench or socket (not shown). In one possible mode of operation, the wrench or socket in turn receives a drill steel and bit (not shown, but hereinafter collectively referred to as the drill "bit") for penetrating into the earth to form the borehole. The drill bit may be of any known type, and preferably is adapted for drilling narrow width (less than 2") boreholes in rock and like materials. Although the chuck 12 is shown as having a generally square cross-section in Figure 1, it should be appreciated that other shapes may be used as well (see, e.g. Figure 2), depending on the

particular types of wrenches or sockets used.

Feed for the drill head 10 and hence the bit to form the borehole may be provided by an adjacent linearly reciprocating mast (not shown), which may be of any conventional type (e.g., a mast having sliders, rods, or C-channels along which the drill head translates to-and-fro relative to the face of the mine passage). An external position sensor (not shown) may also be used to establish the relative position of the bit during the drilling operation (and, as will be understood upon reviewing the description that follows, may generate an output signal sent via transmitter to a remote drill control unit including a complimentary receiver).

With reference now to Figures 2 and 3, the drill head 10 includes an internally mounted or positioned torque sensor 16 (that is, positioned in the interior I of the body or case 11). In one embodiment, the torque sensor 16 comprises an "instrumented" shear pin 20 associated with a drive gear 22 supported by and connected to a drive shaft 23 (such as by way of a key K; see Figure 5b). The drive shaft 23 is supported by suitable bearings (including thrust and ball bearings 25, see Figure 5a) and is coupled via a splined interface to a motor M. The motor M is preferably a two-speed hydraulic motor capable of achieving approximately 660 rpm at 20 GPM in a high speed mode and approximately 400 ft-lb of torque in a low speed mode (e.g., the Eaton 2000 Series Model No. 106-2005, as identified in Figure 5a). The drive gear 22 is in turn intermeshed with and operatively engaged by a driven gear 24 also positioned in the body or case 11 to form part of the drill head 10. By way of a key, spline, or like secure connection, the driven gear 24 is attached to and rotates the chuck 12 receiving and supporting the drill bit.

In the illustrated embodiment, the shear pin 20 is elongated and

is positioned in an opening in a stationary mounting plate 26. One end of the shear pin 20 is associated with a support bracket or mounting part 27 and the other end is associated with a force measuring device, which in the preferred embodiment comprises a load cell 30. The load cell 30 is adapted for measuring the actual loading experienced by the shear pin 20. The load is transmitted to the shear pin 20 by the mounting plate 26, which is connected to the housing of the motor M via bolts 29 (see Figure 3). Thus, the motor M housing is connected to the mounting plate 26, but not the body or case 11 of the drill head 10. Thus, the motor housing tends to be urged in a direction opposite the direction of rotation of the output shaft, which in turn urges the mounting plate 26 into engagement with the shear pin 20. Based on the distance D from the center of the drive gear 22 to the shear pin 20 and the load acting on the load cell 30, the torque experienced by the motor M may be estimated, which is directly proportional to the torque acting on the drill bit, bolt, or other structure positioned in the chuck 12 and being rotated. As should be appreciated, using this torque sensor 14 instead of a fluid pressure transducer eliminates the potential hose losses and motor inefficiencies that would otherwise skew the calculation.

As perhaps best shown in Figure 4, a second sensor 36 is provided for measuring the thrust acting on the drill bit. In the preferred embodiment, the thrust sensor 36 comprises a second load cell 40 positioned adjacent to the chuck 12 for receiving the drill bit, also in the interior I of the body or case 11. More particularly, in the illustrated preferred embodiment, this second load cell 40 is mounted in direct contact with a thrust bearing 42 supporting the chuck 12. The chuck 12 (which as illustrated in Figure 4 may be comprised of a generally hollow inner component 12a for receiving the drill bit and an outer component 12b connected or attached thereto) is in turn

supported by a pair of spaced bearing assemblies 44, which preferably each include a plurality of ball bearings. This arrangement ensures that the thrust force acting on the drill bit in the chuck 12 is isolated from the other components of the drilling force, and thus reduces the influence of external forces and the inefficiencies of the hydraulic system and the mechanical forces required to move the drill head 10.

To measure the rotational speed of the drill bit, a third sensor 46 is used. In the preferred embodiment, the third sensor 46 comprises an inductive-type proximity sensor 50 mounted adjacent to one of the drive gear 22 or the driven gear 24. As illustrated in Figure 5 (in which the drill head 10 is shown upside-down) and Figure 5b, the proximity sensor 50 is positioned adjacent to the periphery of the drive gear 22 and is oriented with a direction of sensing X (as defined by an elongated barrel 51) generally parallel to the axis of rotation A. As noted further below, the detection face 53 is spaced from the drive gear 22 a specific distance in the axial direction.

As is known in the art, an exemplary inductive proximity sensor generates a magnetic field from its detection face. Whenever a detectable object moves into the sensor's field of detection, eddy currents build up in the target and dampen the sensor's magnetic field. This effect triggers the output signal. In the disclosed invention, the proximity sensor 50 thus effectively "sees" the passing teeth 22a of the drive gear 22 as it rotates. Using the output signal from the sensor 50 and the known number of teeth on the drive gear 22, the number of revolutions per minute can be calculated. Likewise, based on the known number of teeth on the driven gear 24, the rotational speed of the chuck 12 and hence the drill bit may be determined (such as by a drill control unit; see below). An exemplary, MSHA approved inductive proximity sensor is Gilson No. B12-G12-YOX-7M with a 12 millimeter barrel

and a 2 millimeter sensing range (see Figure 5a). Instead of sensing the teeth on the drive gear 22, it should also be appreciated that the sensor 46 could also be positioned adjacent to the driven gear 24 to obtain a similar reading and eliminate the need for a conversion. Moreover, instead of sensing the teeth on the gear 22 or 24, it should be appreciated that the third sensor 46 could be used to detect the passing of another indicia (such as a hole provided in the gear or a projection extending from it).

As shown in the block diagram of Figure 6, the output of each sensor 16, 36, 46 is coupled to at least one transmitter 60 located on the drill head 10 (which may be supported on the mast T). In the preferred embodiment, the transmitter 60 modulates and sends radio frequency signals representative of the parameters of the drilling operation being measured to a drill control unit (DCU) 62 including a suitable receiver 64 for receiving the transmitted signals. In the preferred embodiment, the arrangement is thus considered "wireless" in the sense that no external cables or lines are required on the exterior E of the drill head 10. The DCU 62 may be mounted on the boom (not shown) supporting the mast T and drill head 10 or elsewhere on the drilling machine L. The transmitter 60 may be programmed to communicate only with the corresponding DCU 62 to prevent it from interfering with any other DCU's or other radio-controlled devices. Since the goal is to eliminate the wires normally provided between the drill head 10 and the DCU 62, the transmitter 60 and the associated sensors 16, 36, 46 are preferably powered by an onboard battery 66. The sensors 16, 36, 46 are preferably of a type requiring minimum power consumption to extend the battery life. Although optional, use of a single transmitter 60 for transmitting all three output signals generated by the sensors 16, 36, 46 (and possibly the signal from an external position sensor 68) in the preferred embodiment further reduces the power

requirements.

As described in commonly assigned U.S. Patent No. 6,216,800 and U.S. Published Patent Application No. 2001/0050186, the DCU 62 may be programmed to perform feedback control of the drilling operation based on the outputs of the sensors 16, 36, 46. In particular, the feed rate and rotational speed may be regulated to ensure the maximum penetration per revolution of the drill bit depending on the type of material encountered (hard vs. soft), as well as to reduce the feed rate and speed when harder materials are encountered to maximize bit life. The torque measurement may also be used to control the drilling operation or to cut-off the motor to prevent a catastrophic failure of the drill bit. The operating conditions reported may also be used to obtain a map of the drilling environment, including the identification of different layers of strata adjacent to the borehole, the relative distance of each later from the bore hole entry point, and any voids present (which in the underground environment may alert the drill operator to exercise caution in view of potentially unstable roof conditions, or allow for the development of a roof control plan to accommodate detected potential weaknesses in the overburden).

While the focus of the foregoing discussion is on using the drill head 10 for drilling a borehole, it should also be appreciated that the output signals generated by one or more of the sensors may be used during a subsequent roof bolting operation. For example, the remotely transmitted torque, rotational speed, or position outputs can be used to monitor and control an automated sequence for installing a roof bolt. An automated means for inserting a resin cartridge into the bore hole (such as a resin injector or other structure for holding resin cartridges or "sausages" and a source of a driving fluid for supplying the resin to the borehole once formed by fluid

pressure) before installing the roof bolt may also be employed (see, e.g., U.S. Patent No. 6,135,674, the disclosure of which is incorporated herein by reference).

As perhaps best shown in Figure 5a, the drill head 10 may also include an inlet 70 for receiving a flow of bailing fluid, such as water or air. In the typical arrangement the fluid is passed through a channel in the drill bit into the borehole to flush away dust and cuttings. The cuttings and dust may then be filtered from the fluid and collected for later disposal.

The foregoing descriptions of various embodiments of the invention are provided for purposes of illustration, and are not intended to be exhaustive or limiting. Modifications or variations are also possible in light of the above teachings. For example, any one of the sensors alone could be used with a single transmitter, or all sensors could be coupled to different transmitters (although this may be less desirable in terms of power consumption). The embodiments described above were chosen to provide the best application to thereby enable one of ordinary skill in the art to utilize the disclosed inventions in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.

In the Claims

1. An instrumented drill head intended use with a drilling machine having a controller for controlling a drilling or roof bolting operation performed using a drill bit or roof bolt associated with the drill head, the controller including a receiver, comprising:

a first sensor for measuring and generating an output signal representative of a first parameter of the drilling operation; and

a transmitter adapted for transmitting the signal to the receiver.

2. The drill head according to claim 1, wherein the first parameter is a torque level, the first sensor includes a shear pin associated with a load cell for measuring a force acting on the shear pin, and the output signal is representative of the force acting on the shear pin.

3. The drill head according to claim 2, wherein an actual torque level on the drill bit is estimated using the force acting on the shear pin and a distance between the shear pin and the center of a drive gear for driving the drill bit.

4. The drill head according to claim 1, wherein the first parameter is a thrust level and the first sensor is a load cell for measuring the thrust level.

5. The drill head according to claim 1, wherein the first parameter is a rotational speed of the drill bit and the first sensor is an inductive proximity sensor for measuring the rotational speed of the drill bit.

6. The drill head according to claims 1-5, wherein the first sensor is mounted internal to the drill head.

7. The drill head according to claim 1, wherein the first parameter is a torque level and the first sensor comprises a shear pin and a load cell for measuring the force acting on the shear pin, and further including:

a second sensor for measuring the thrust level acting on the drill bit and generating a second signal;

a third sensor for measuring the rotational speed of the drill bit and generating a third signal; and wherein

the transmitter also transmits the second and third signals to the controller.

8. The drill head according to claim 1, wherein the transmitter is mounted on the drill head and the controller is mounted separate from the drill head.

9. The drill head according to any of claims 1-8, further including an external position sensor for generating a position signal representative of a relative position of the drill bit, wherein the position signal is transmitted to the controller via the transmitter.

10. An instrumented drill head for performing a drilling or bolting operation using a drill bit or roof bolt, comprising:

a body or case having an interior and an exterior;

a first sensor positioned in the interior of the case for measuring

and generating an output signal representative of a first parameter of the drilling operation;

a controller separate from the case for controlling the drilling operation based at least in part on the first parameter, said controller including a receiver; and

a transmitter for transmitting the signal to the receiver.

11. An instrumented drill head for performing a drilling or bolting operation using a drill bit or roof bolt, comprising:

a first sensor for measuring and generating an output signal representative of a first parameter of the drilling operation; and

a controller for controlling the drilling operation based at least in part on the first parameter;

wherein the output signal is provided to the controller without the use of a direct physical connection, such as a wire.

12. A drilling machine including the drill head according to any of claims 1-11.

13. The drilling machine of claim 12, further including a mast for supporting the drill head such that the drill bit may be advanced toward and away from the material being drilled.

14. A roof bolting machine including the drill head according to any of claims 1-11, and further including means for inserting a resin cartridge into a borehole formed during the drilling operation.

15. A method of drilling a borehole using the drill head of claims 1-11 or the machine of claims 12-14.

16. A method of installing a roof bolt using the drill head of claims 1-11 or the machine of claims 12-14.

In the Claims

1. A system for controlling a drilling or roof bolting operation, comprising:

an input device for manually controlling at least one aspect of the drilling or roof bolting operation;

a controller associated with at least one neutral switch; and

an actuator for actuating the drilling or roof bolting operation, the actuator including a valve associated with the input device and the neutral switch;

wherein the input device is operative for controlling the drilling or roof bolting operation only when the valve is in a neutral position, as determined using the neutral switch.

2. The system according to claim 1, wherein the manual input device includes an enable switch associated with the controller.

3. The system according to claim 2, wherein the manual input device is operative for controlling the drilling or roof bolting operation only when the valve is in the neutral position and the enable switch is closed.

4. The system according to claim 2, wherein the manual input device is operative for controlling the drilling or roof bolting operation only when the enable switch is closed before the valve is moved from the manual input device.

5. The system according to claims 3 or 4, wherein the enable

switch may be opened once the valve is moved from the neutral position with the enable switch closed without rendering the manual input device inoperative.

6. The system according to any of claims 1-5, wherein the controller includes a circuit for evaluating whether the enable switch is open or closed at predetermined intervals, wherein the input device is rendered inoperative for controlling the drilling or bolting operation if the controller determines that the enable switch is closed for a predetermined number of intervals.

7. The system according to any of claims 1-6, wherein the manual input device is a joystick connected to the valve and the enable switch is closed by a trigger associated with the joystick.

8. The system according to claim 1, wherein the actuator includes a valve package that is energized to permit a fluid flow to reach the valve once the controller determines that: (1) an enable switch associated with the input device is closed; and (2) the neutral switch is closed.

9. The system according to any of claims 1-8, wherein the actuator includes at least one fluid-operated motor for controlling a feed or a rotation of either: (1) a drill bit for performing the drilling operation; or (2) a roof bolt used in the bolting operation.

10. A manual input device for use by a single hand of an operator having a palm and fingers, comprising:

a body;

a head including an upper portion and a lower portion including an interface;

a low-profile trigger positioned adjacent the interface, the trigger including a body having a generally semi-circular face for engagement by at least one of the operator's fingers when the palm is positioned on or generally adjacent the upper portion of the head; and

a switch associated with the trigger.

11. The device according to claim 10, wherein the upper portion is hemispherical, the lower portion is frusto-conical, and the two portions are secured together using fasteners recessed in the upper portion.

12. The device according to claim 10, wherein the face of the trigger is rounded from a top edge to a bottom edge of the body.

13. The device according to claim 10, wherein a slot is defined at the interface and a portion of the trigger body projects through the slot in a home position and when the switch is in an open condition.

14. The device according to claim 13, further including means for biasing the trigger toward the home position.

15. The device according to claim 10, wherein the body is an elongated shaft pivotally mounted to a stable support structure.

16. A drilling or roof bolting machine including the manual

operator input device of any of claims 10-15.

17. A method of controlling a drilling or roof bolting operation including the manual operator input device of any of claims 10-15.

18. A system for controlling a machine for use in performing a drilling or roof bolting operation, comprising:

a fluid-operated motive device for moving the machine;

a valve for controlling the flow of fluid to the motive device;

an input device for controlling the position of the valve;

a neutral switch associated with the valve; and

wherein the motive device is capable of moving the machine only when the valve is in a neutral position, as determined using the neutral switch..

19. The system according to claim 18, wherein the input device includes an enable switch, and wherein the motive device is capable of moving the machine only when the enable switch is closed before the neutral switch is closed.

20. A method of rock drilling or roof bolting using the machine of claim 18 or 19.

21. An input device for controlling a position of first and second valve spools, comprising:

a lever;

a first ball joint supporting the lever;

a first linkage connecting the lever to the first spool;

a second linkage connecting the lever to the second spool;

wherein movement of the lever to and fro in a first direction results in corresponding movement of the first spool and movement of the lever to and fro in a second direction results in corresponding movement of the second spool.

22. The input device according to claim 21, wherein the movement in the first direction and the movement in the second direction occurs simultaneously.

23. The input device according to claim 21, wherein the movement in the first direction occurs before the movement in the second direction.

24. A drilling or roof bolting machine including the manual input device of any of claims 21-23.

25. The machine according to claim 24, wherein the first spool is associated with a rotation valve section for controlling a flow of fluid to a rotation motor adapted for rotating a drill bit or roof bolt and the second spool is associated with a feed valve section for controlling a flow of fluid to a feed motor for feeding the drill bit or roof bolt.

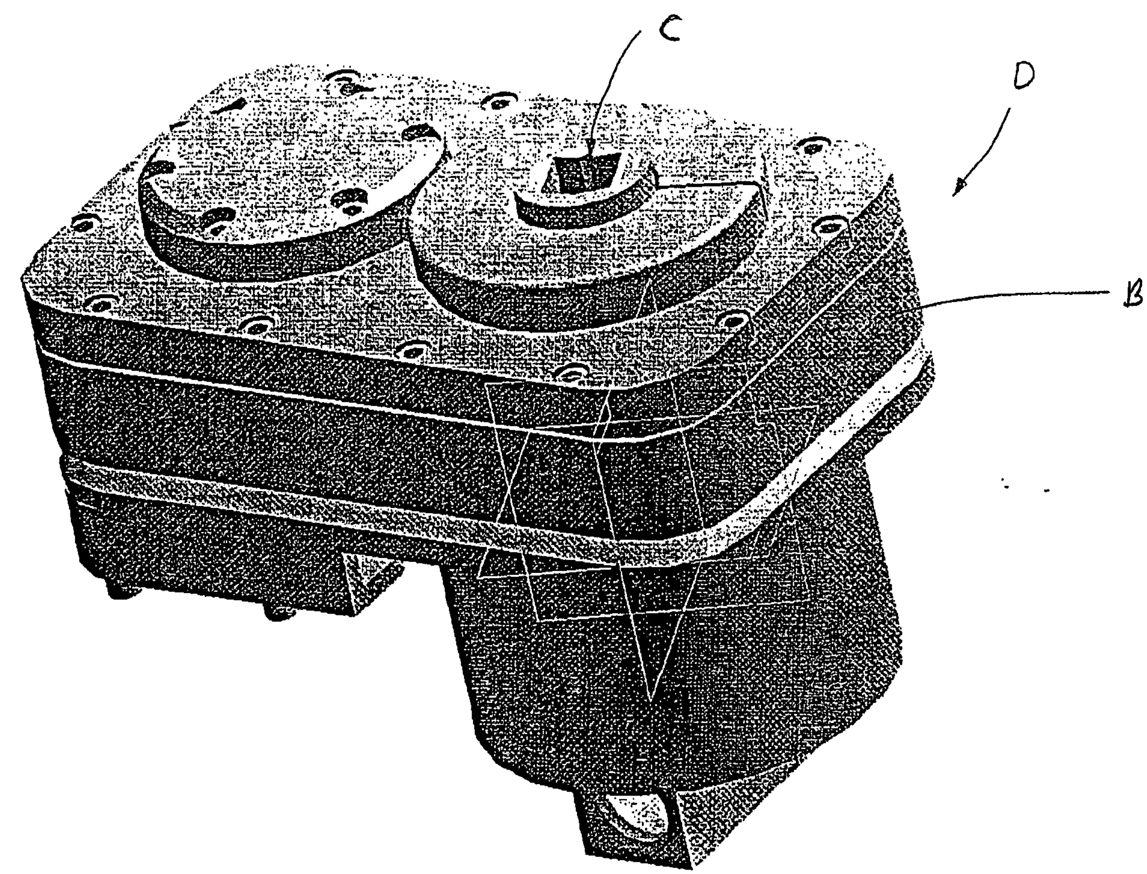
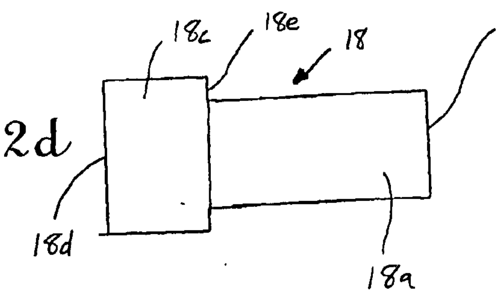


Fig. 1

Fig.2d



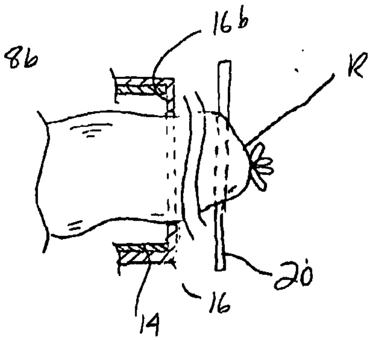


Fig. 2c

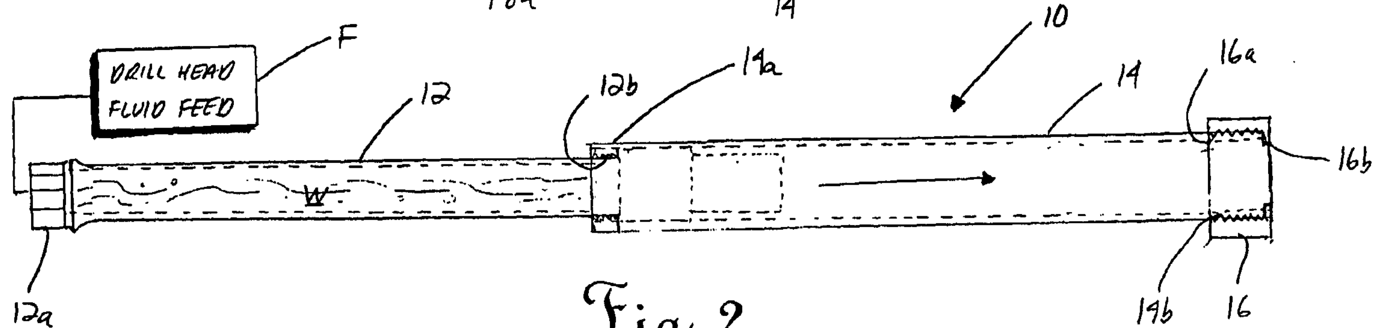


Fig. 2

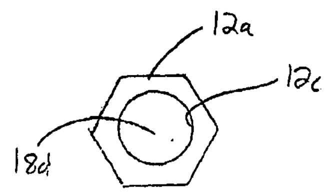


Fig. 2a

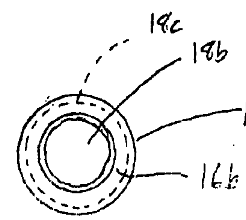


Fig. 2b

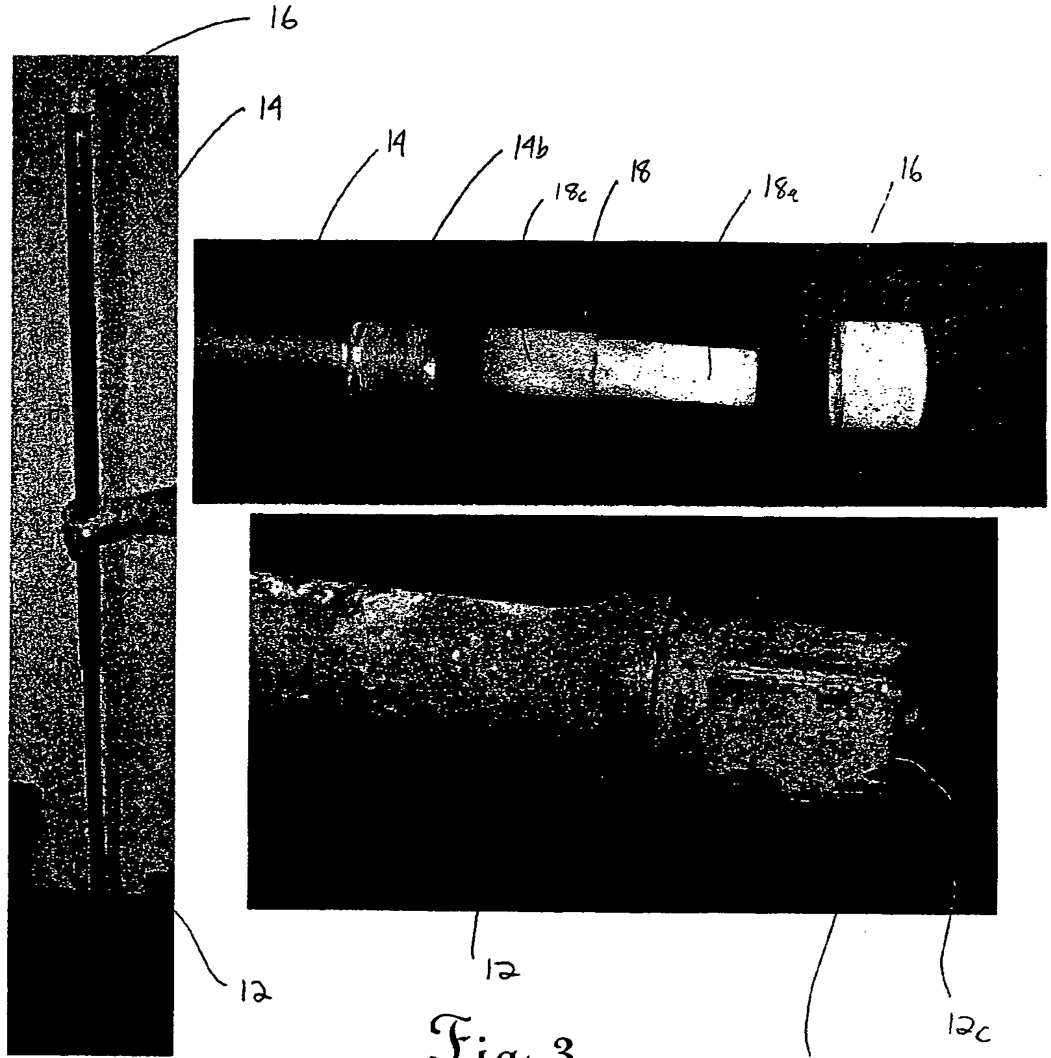
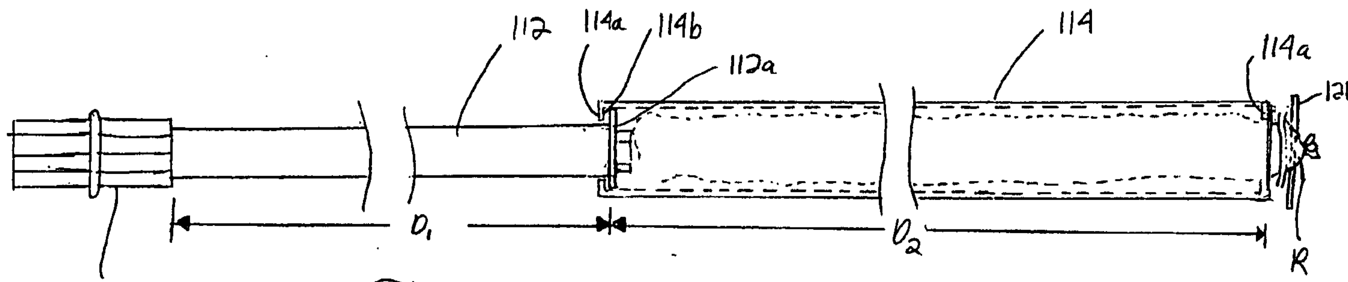
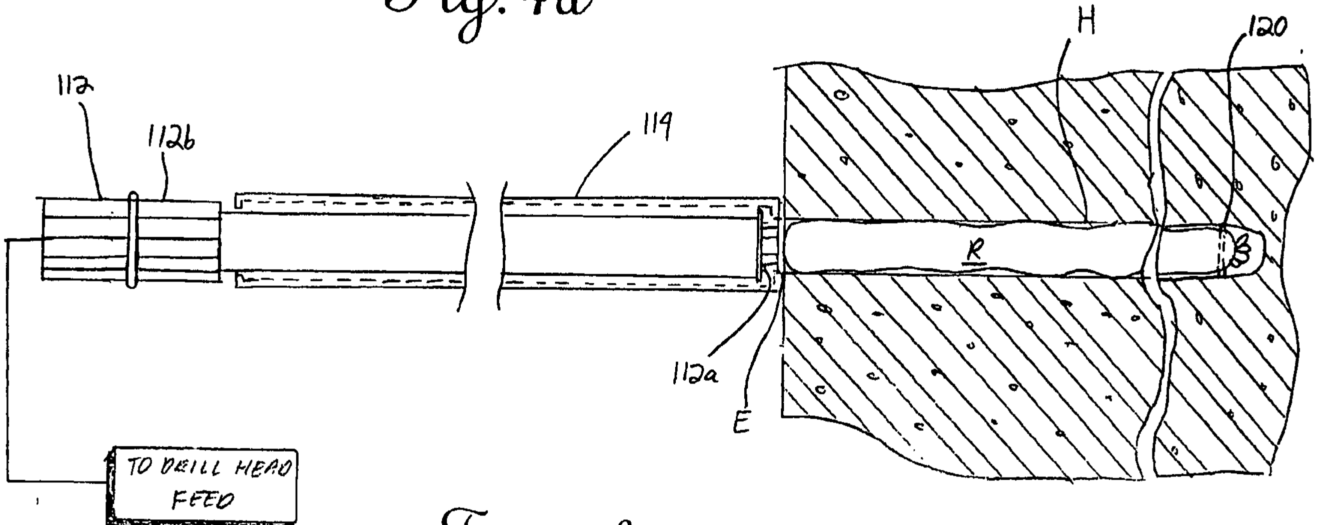


Fig. 3


112
114a
114b
112a
114
114a
120
D_1
D_2
R
112b
Fig. 4a


H
120
112
112b
119
R
112a
E
TO DRILL HEAD FEED
Fig. 4b

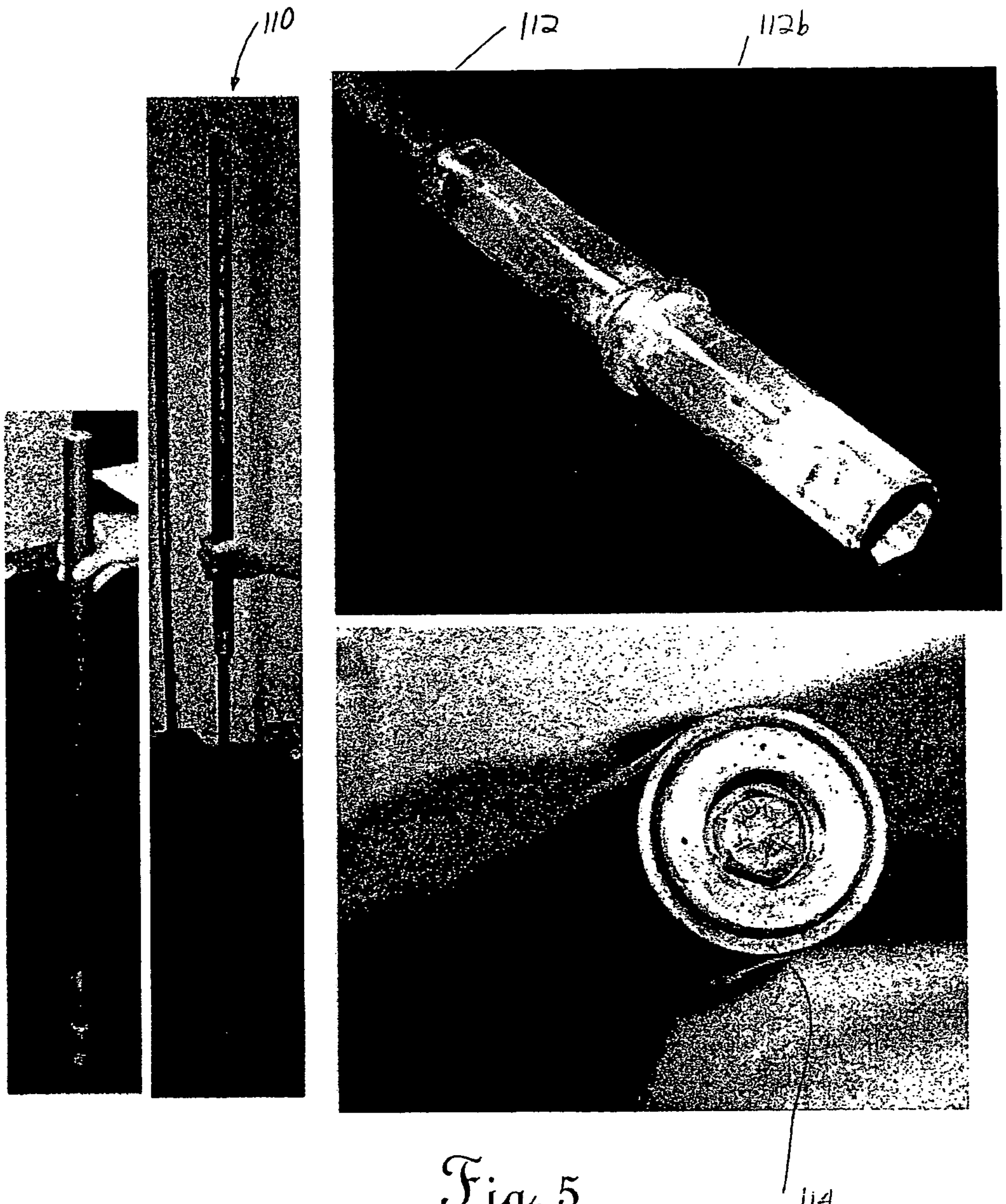


Fig. 5

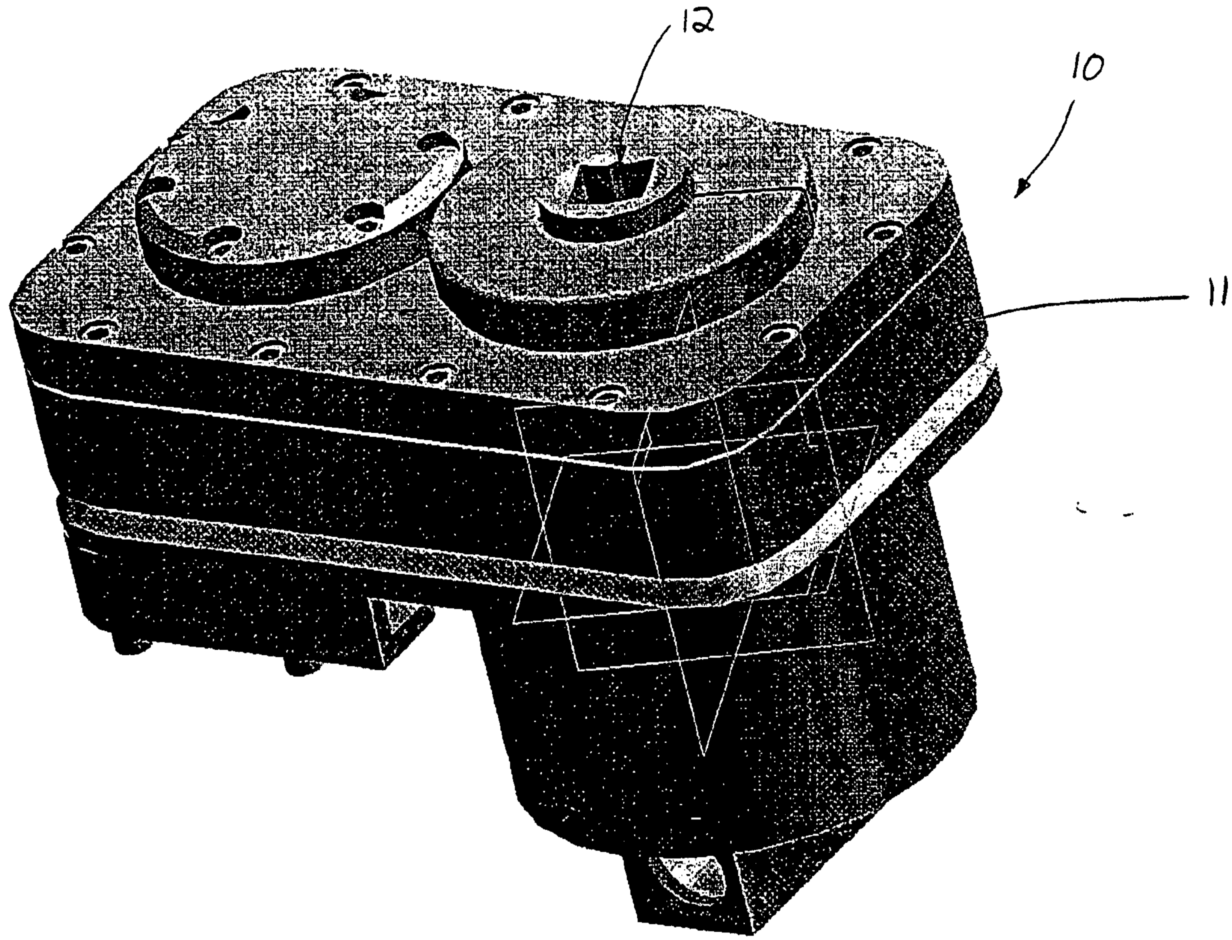
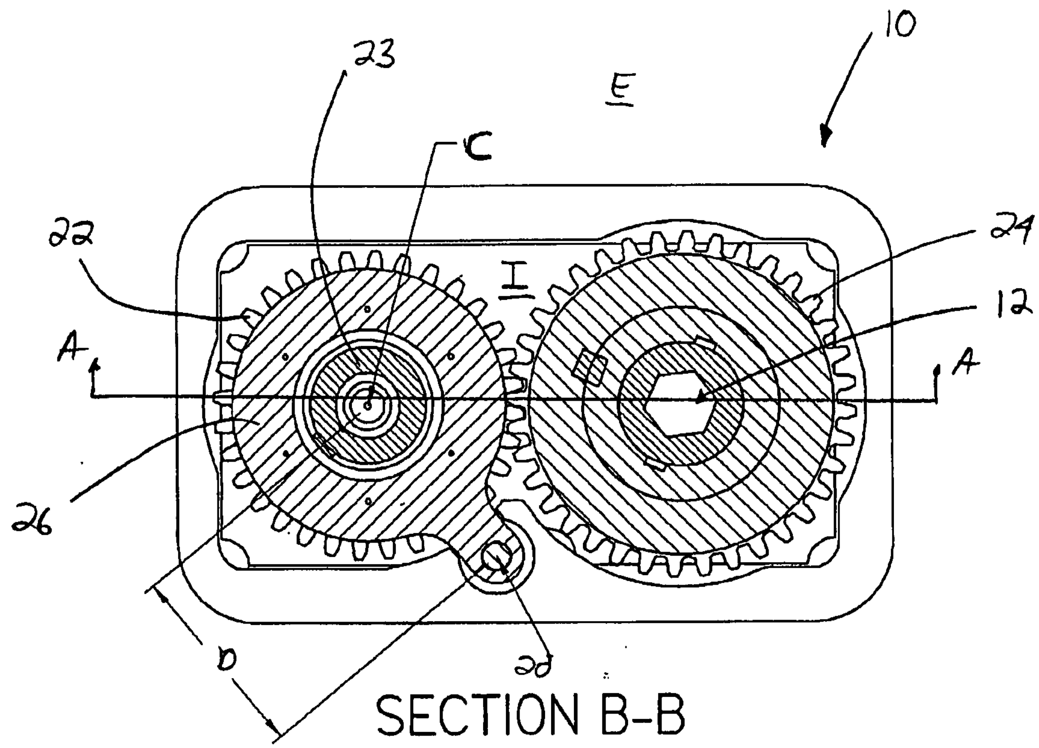


Fig. 1



SECTION B-B

Fig. 2

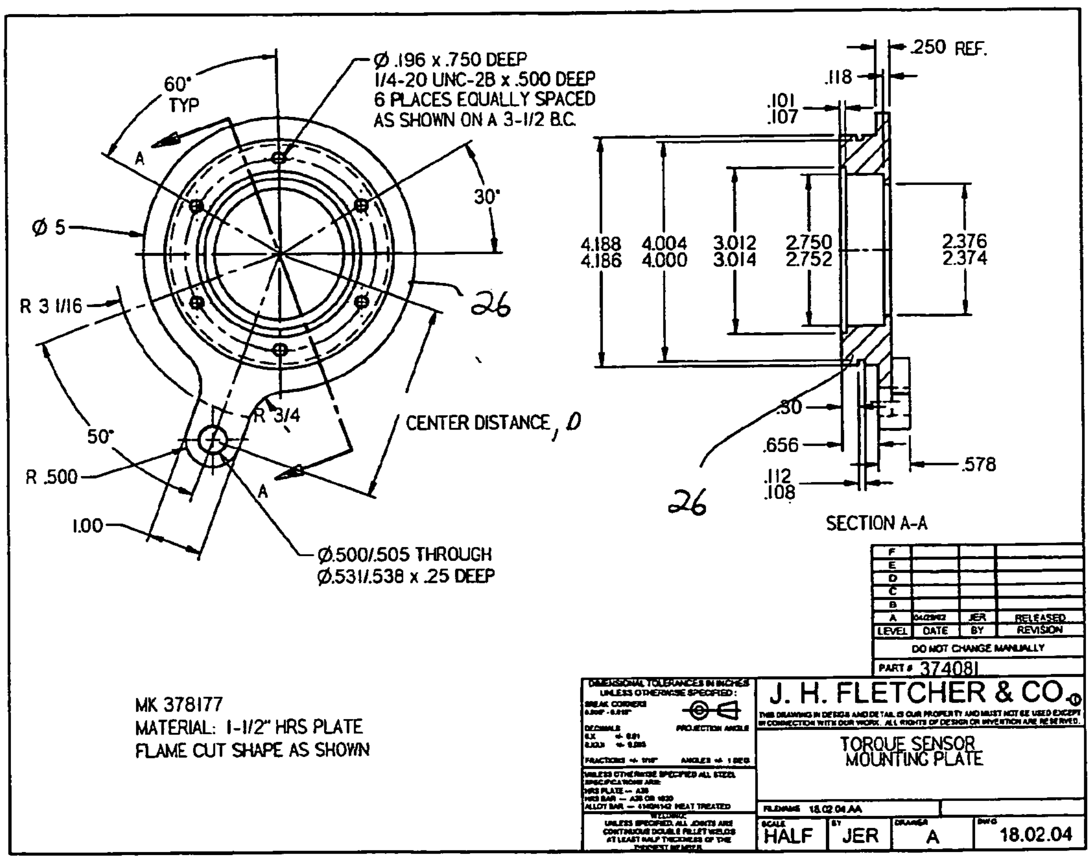
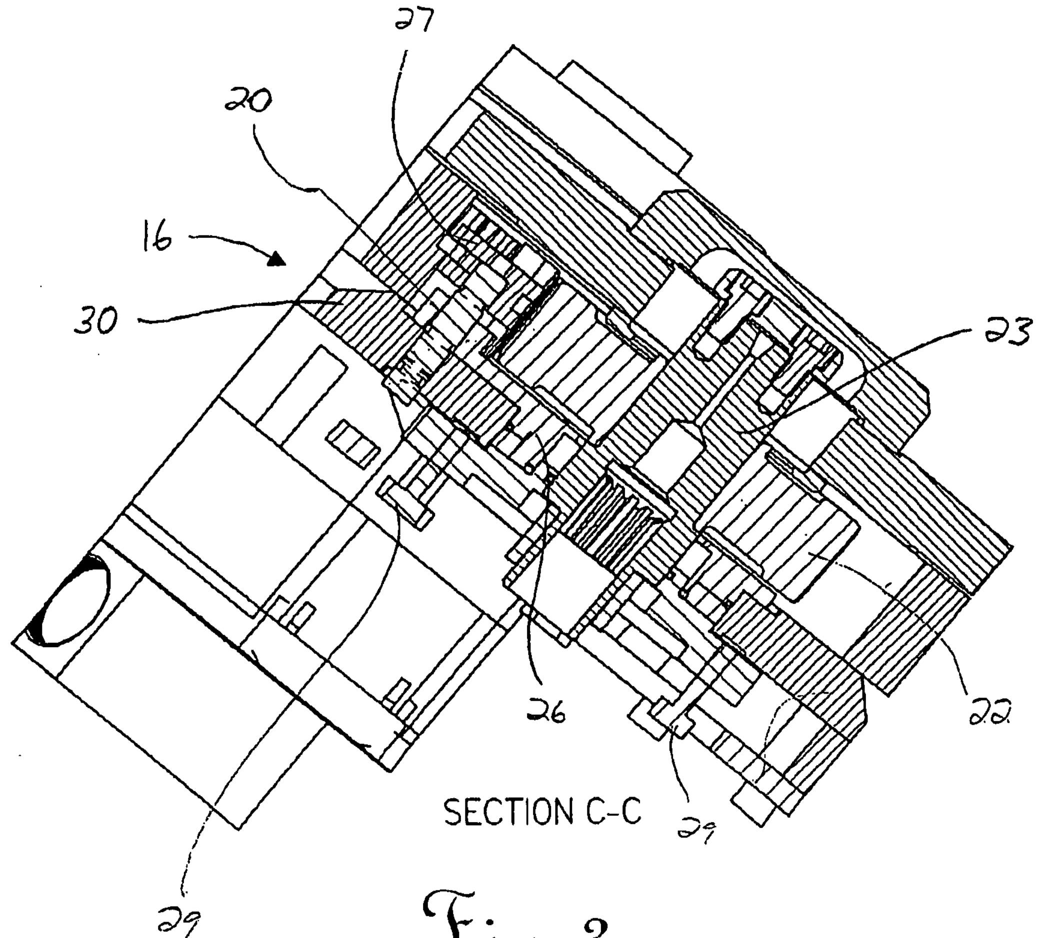

Ø .196 x .750 DEEP
1/4-20 UNC-2B x .500 DEEP
6 PLACES EQUALLY SPACED
AS SHOWN ON A 3-1/2 B.C.
60° TYP
A
30°
Ø 5
R 3 1/16
26
50°
R 3/4
CENTER DISTANCE, D
R .500
A
1.00
Ø.500/.505 THROUGH
Ø.531/.538 x .25 DEEP
.250 REF.
.118
.101
.107
4.188
4.186
4.004
4.000
3.012
3.014
2.750
2.752
2.376
2.374
.50
.656
.578
.112
.108
26
SECTION A-A
MK 378177
MATERIAL: 1-1/2" HRS PLATE
FLAME CUT SHAPE AS SHOWN
A
RELEASED
LEVEL
DATE
BY
REVISION
DO NOT CHANGE MANUALLY
PART # 374081
J. H. FLETCHER & CO.
TORQUE SENSOR
MOUNTING PLATE
HALF
JER
A
18.02.04

Fig. 2a



SECTION C-C

Fig. 3

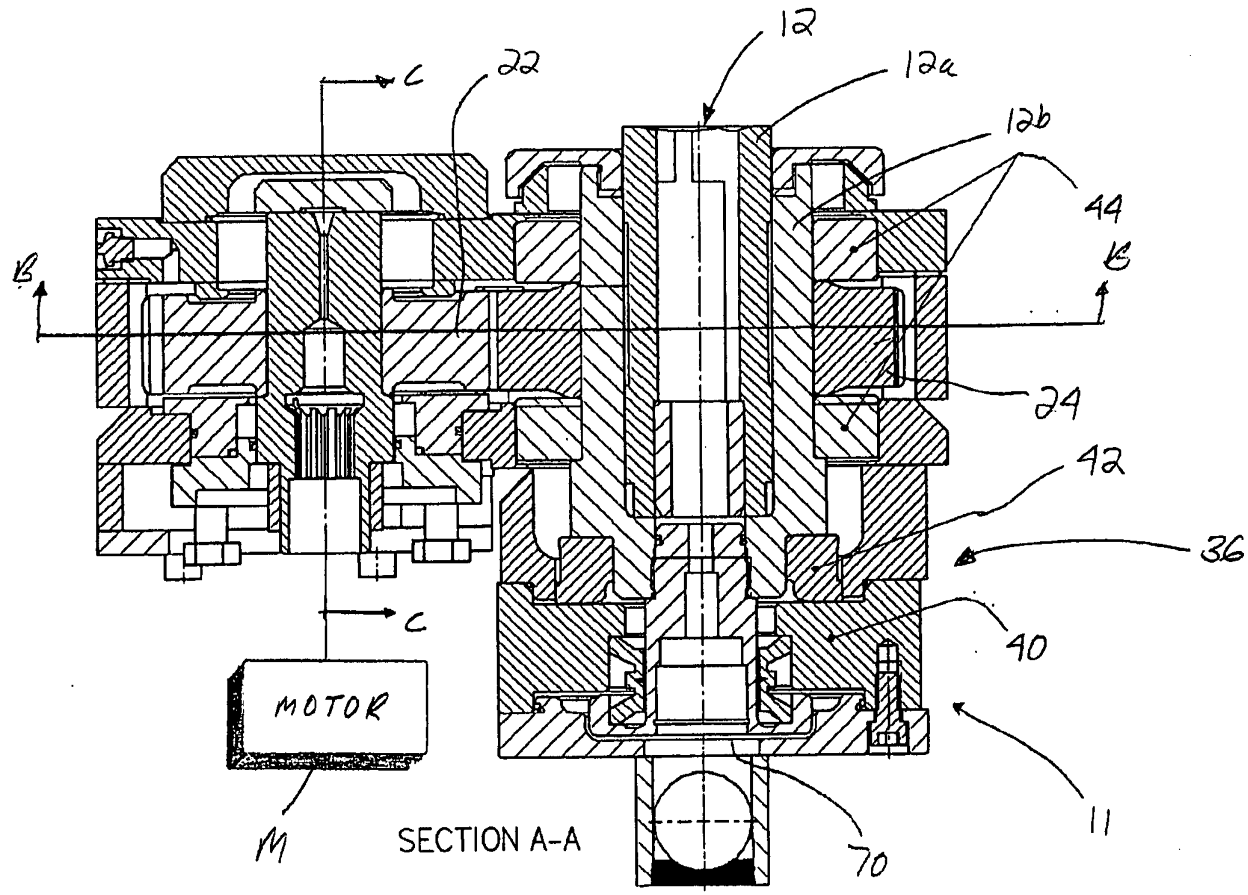


Fig. 4

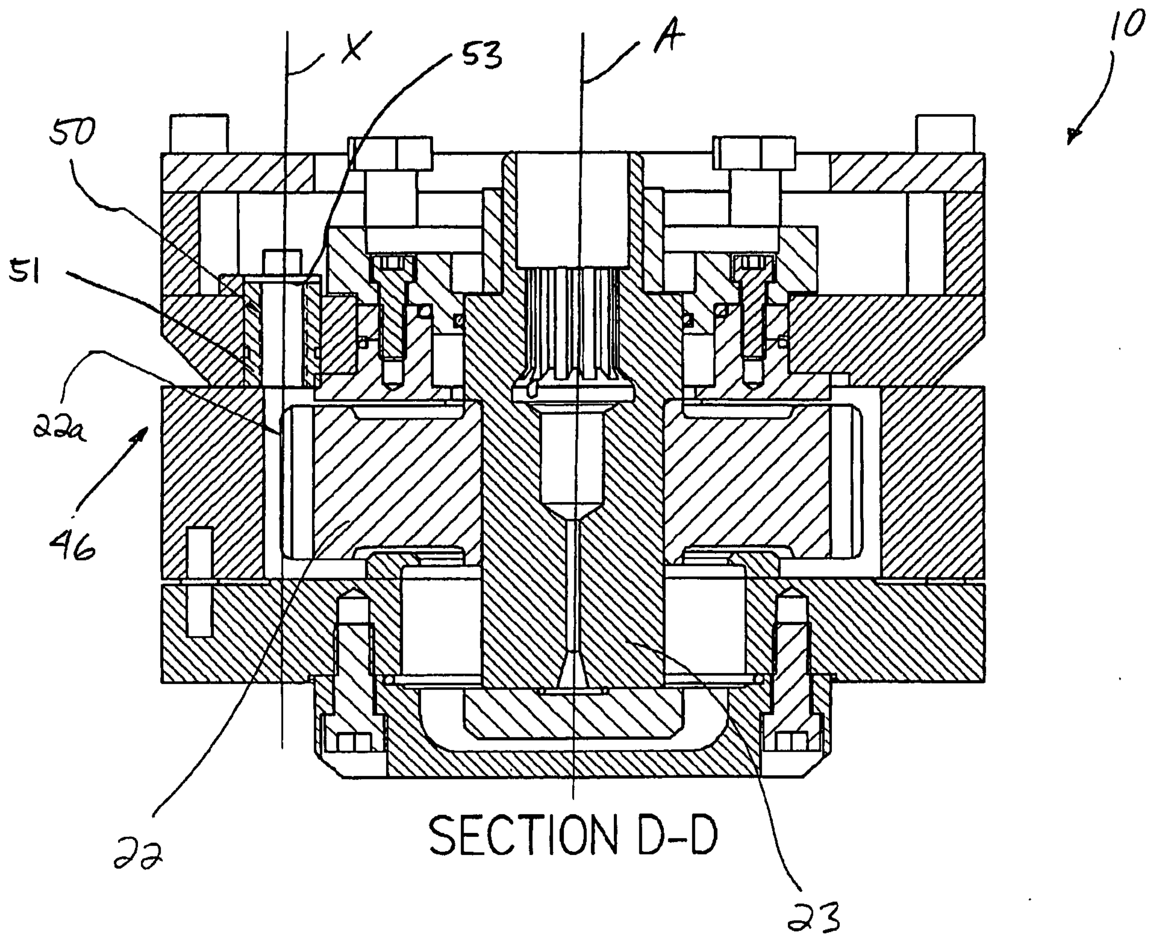


Fig. 5

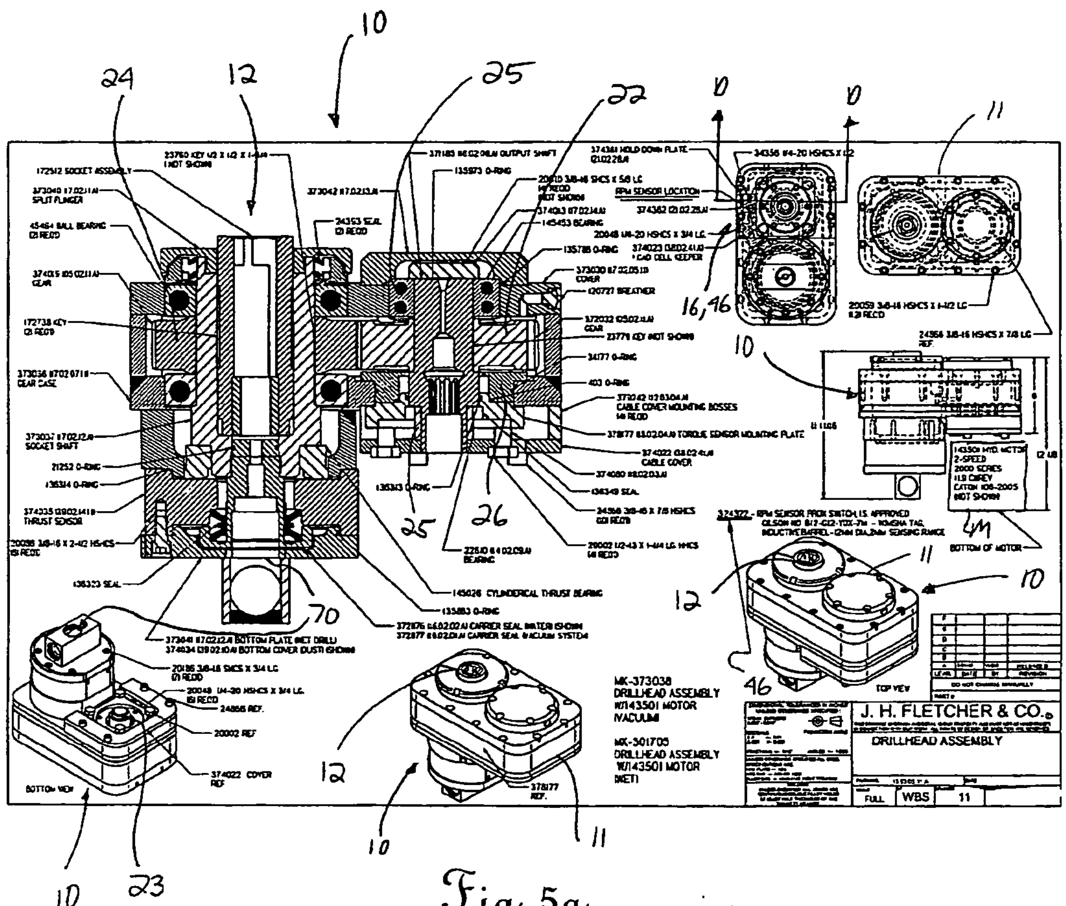
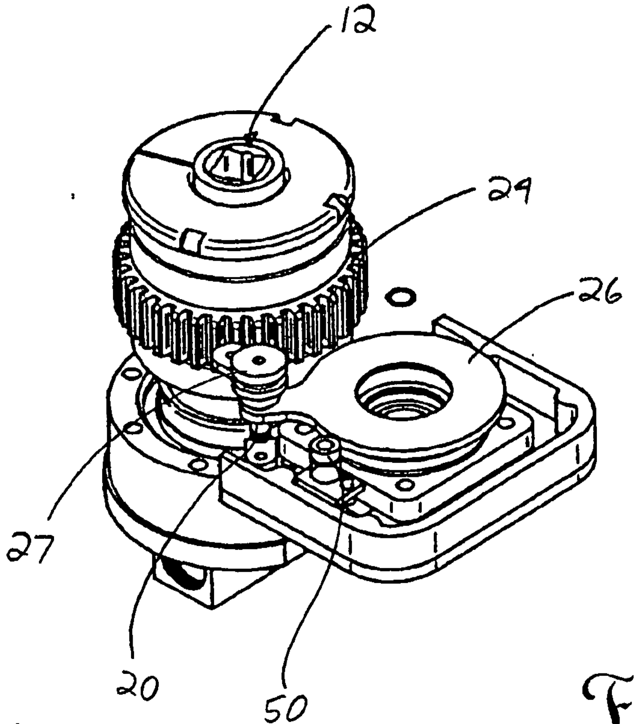

J. H. FLETCHER & CO.
DRILLHEAD ASSEMBLY
MK-373038
DRILLHEAD ASSEMBLY
W/143501 MOTOR
(VACUUM)
MK-301705
DRILLHEAD ASSEMBLY
W/143501 MOTOR
(WET)
TOP VIEW
BOTTOM VIEW
BOTTOM OF MOTOR
RPM SENSOR LOCATION
145026 CYLINDRICAL THRUST BEARING
FULL
WBS
11
10
12
24
25
22
16,46
26
70
23
46
44

Fig. 5a



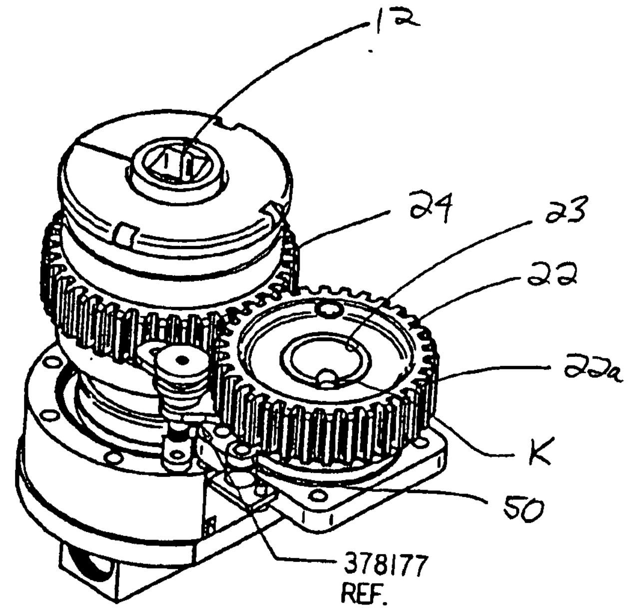


Fig. 5b

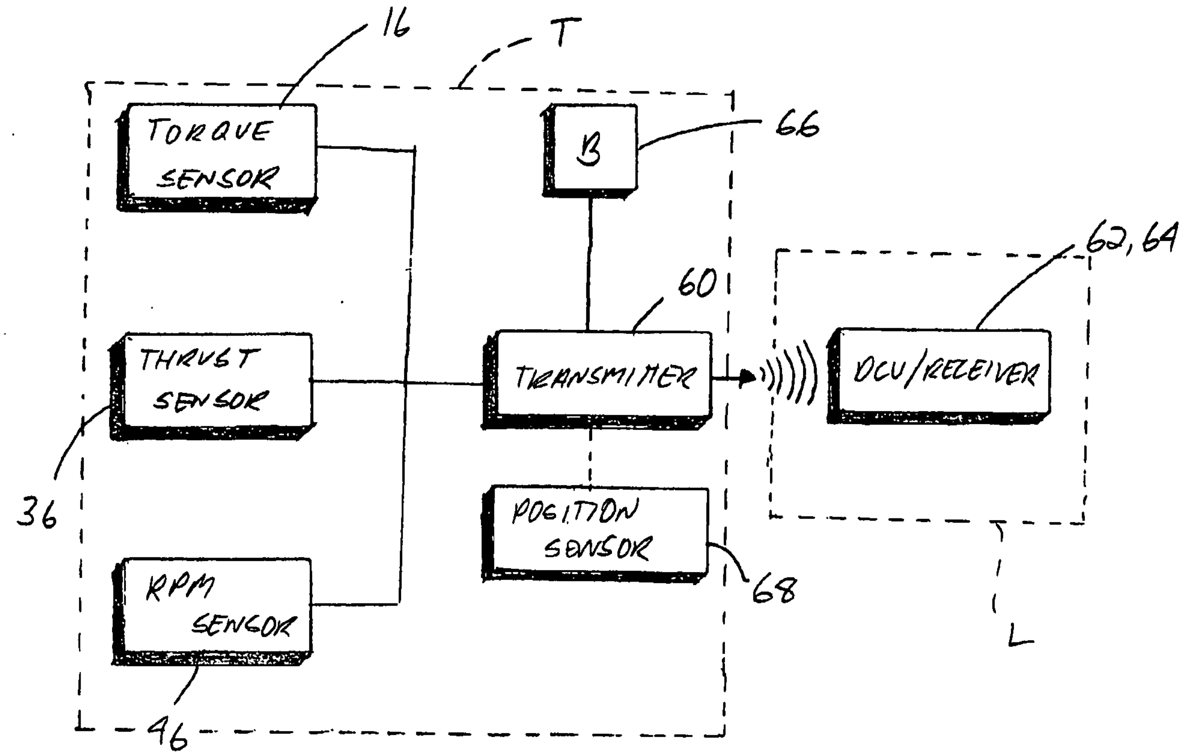
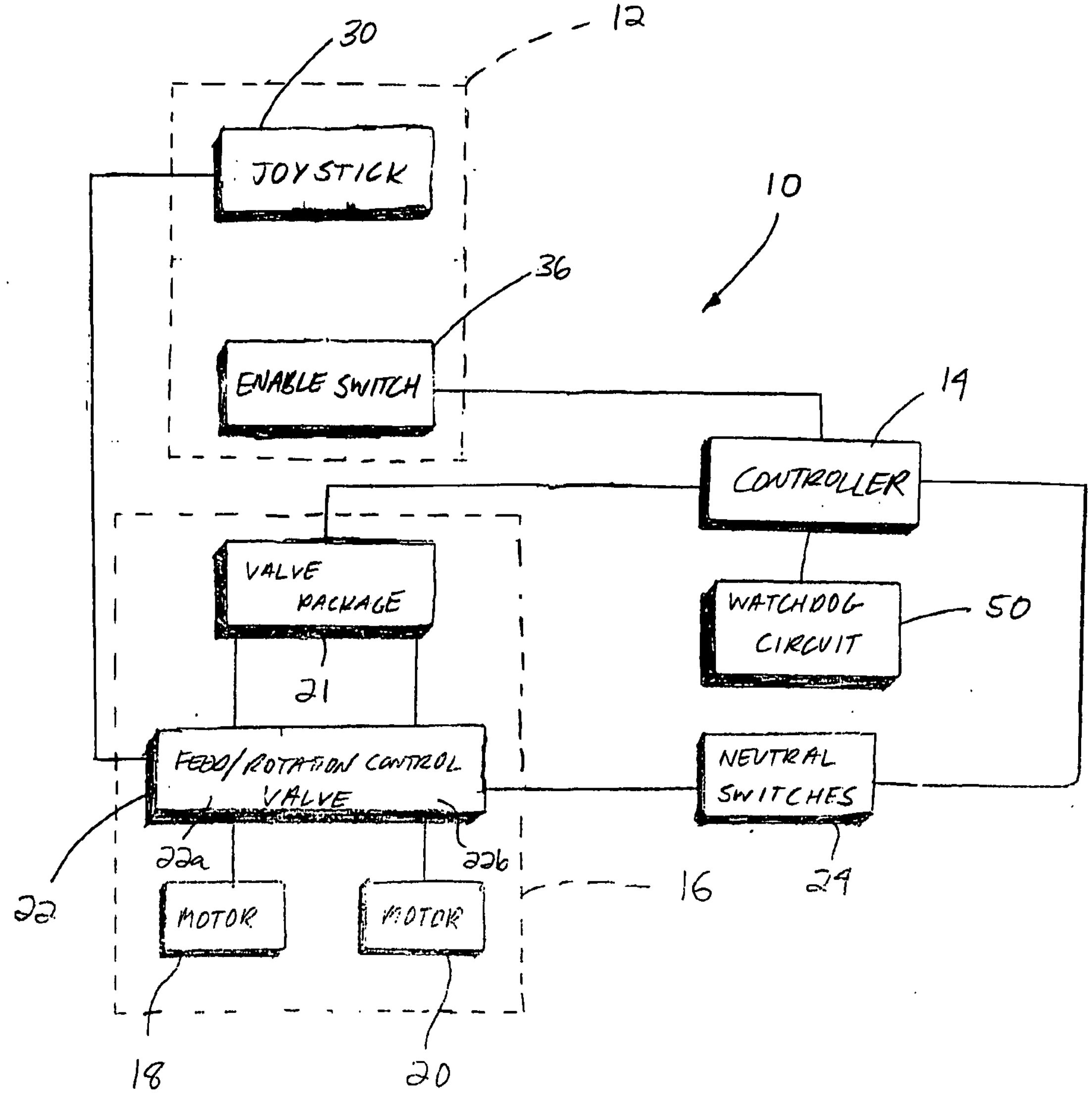

16
T
TORQUE SENSOR
B
66
62, 64
60
THRUST SENSOR
TRANSMITTER
DCU/RECEIVER
36
POSITION SENSOR
68
RPM SENSOR
L
46

Fig. 6

Fig. 1



30
12
JOYSTICK
10
36
ENABLE SWITCH
14
CONTROLLER
VALVE PACKAGE
21
WATCHDOG CIRCUIT
50
FEED/ROTATION CONTROL VALVE
NEUTRAL SWITCHES
22
22a
22b
16
24
MOTOR
MOTOR
18
20

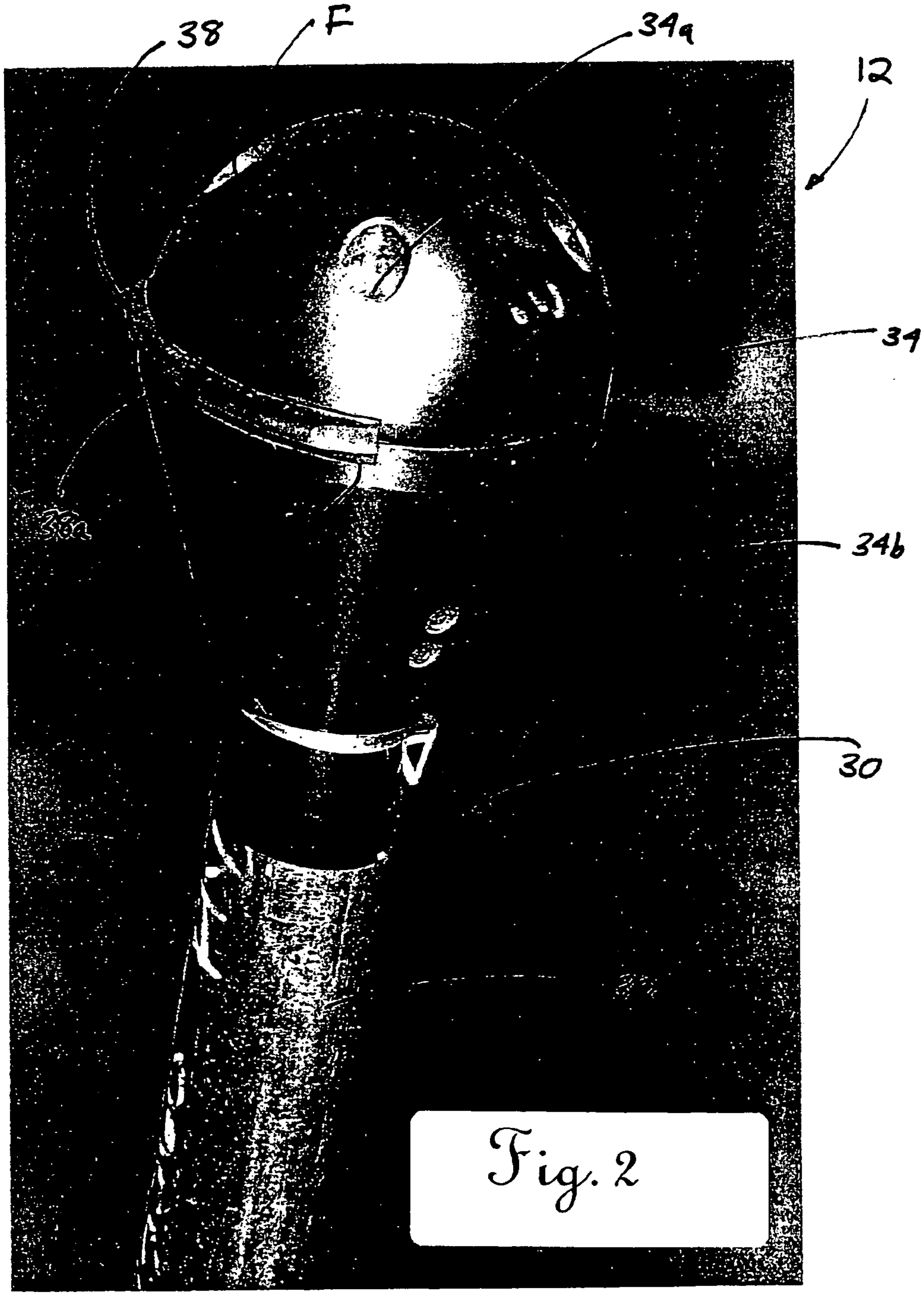


Fig. 2

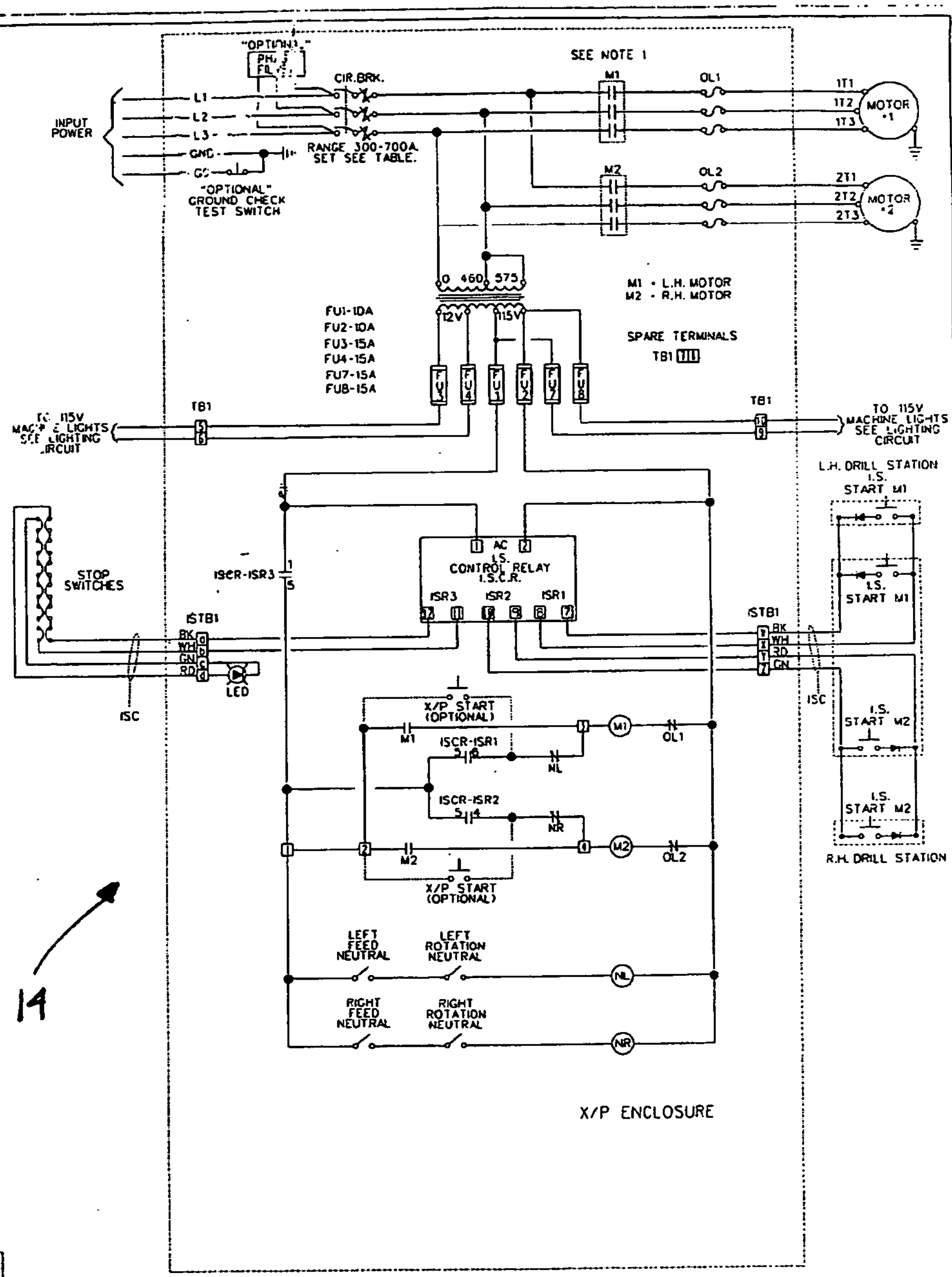


Fig. 3

NOTE 1: SYMBOL SHOWN FOR EITHER MAGNETIC OR VACUUM CONTACTORS

H.P.	SERVICE FACTOR	FL. A.	VOLTAGE	O.L. SET	BRK. SET MAX
40	1.0	53.5	440V	46-50	695A
40	1.0	42.8	550V	37-42	556A
40	1.15	53.5	440V	51-55	695A
40	1.15	42.8	550V	41-46	556A
50	1.0	65	440V	56-61	845A
50	1.0	52	550V	41.6-46.3	676A
50	1.15	65	440V	62-66	845A
50	1.15	52	550V	46.4-50.0	676A
75	1.0				
75	1.15				

NOTE: MACHINE CIRCUIT BREAKER SHOULD BE SET NO HIGHER THAN THE OUTBY CIRCUIT BREAKER.

J.H. FLETCHER & CO.

SCHEMATIC DIAGRAM DUAL 40/50/75 HP 440/550V AC

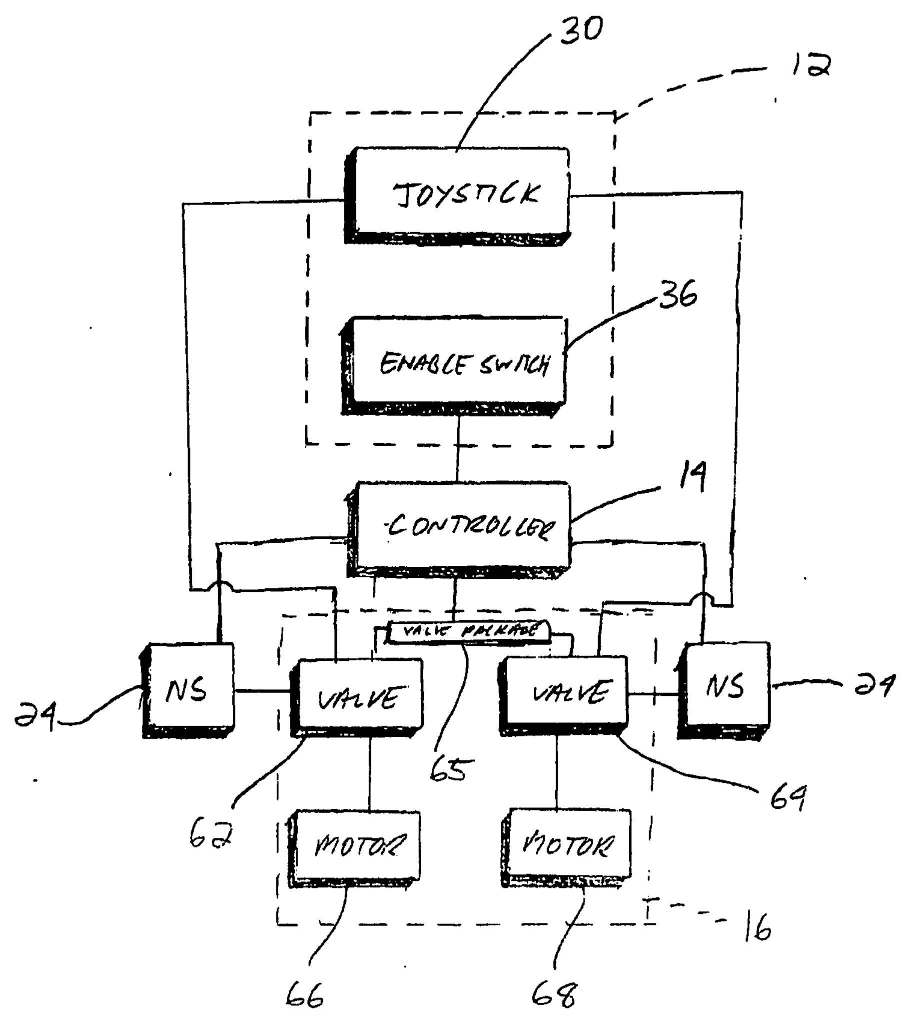
DATE 9-28-02 SCALE NTS DR BY CMC

DWG AC-XXXX SH 1 OF 1

FILENAME: jsfbneutralstart.dgn

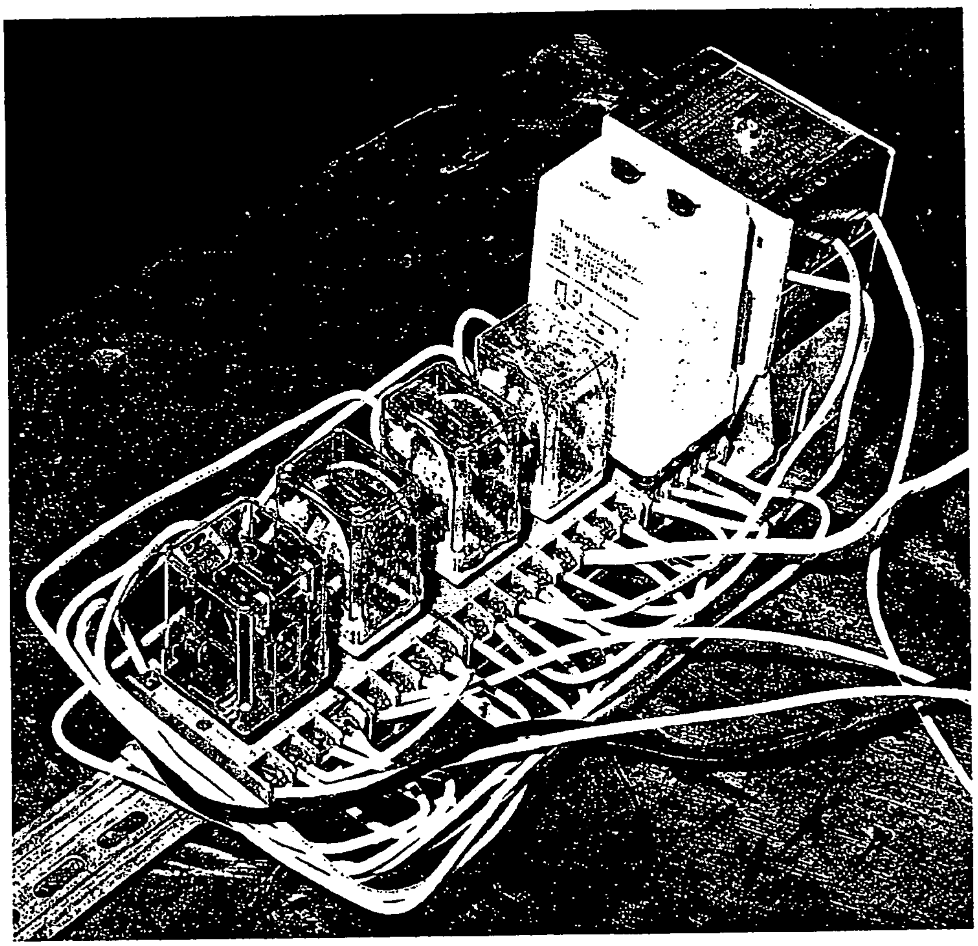
DO NOT CHANGE MANUALLY

...\jsfbneutralstart.dgn Apr. 18, 2003 09:22:09



30
12
JOYSTICK
36
ENABLE SWITCH
14
CONTROLLER
VALVE PACKAGE
NS
VALVE
VALVE
NS
24
24
65
62
64
MOTOR
MOTOR
16
66
68

Fig. 4



14

Fig. 5

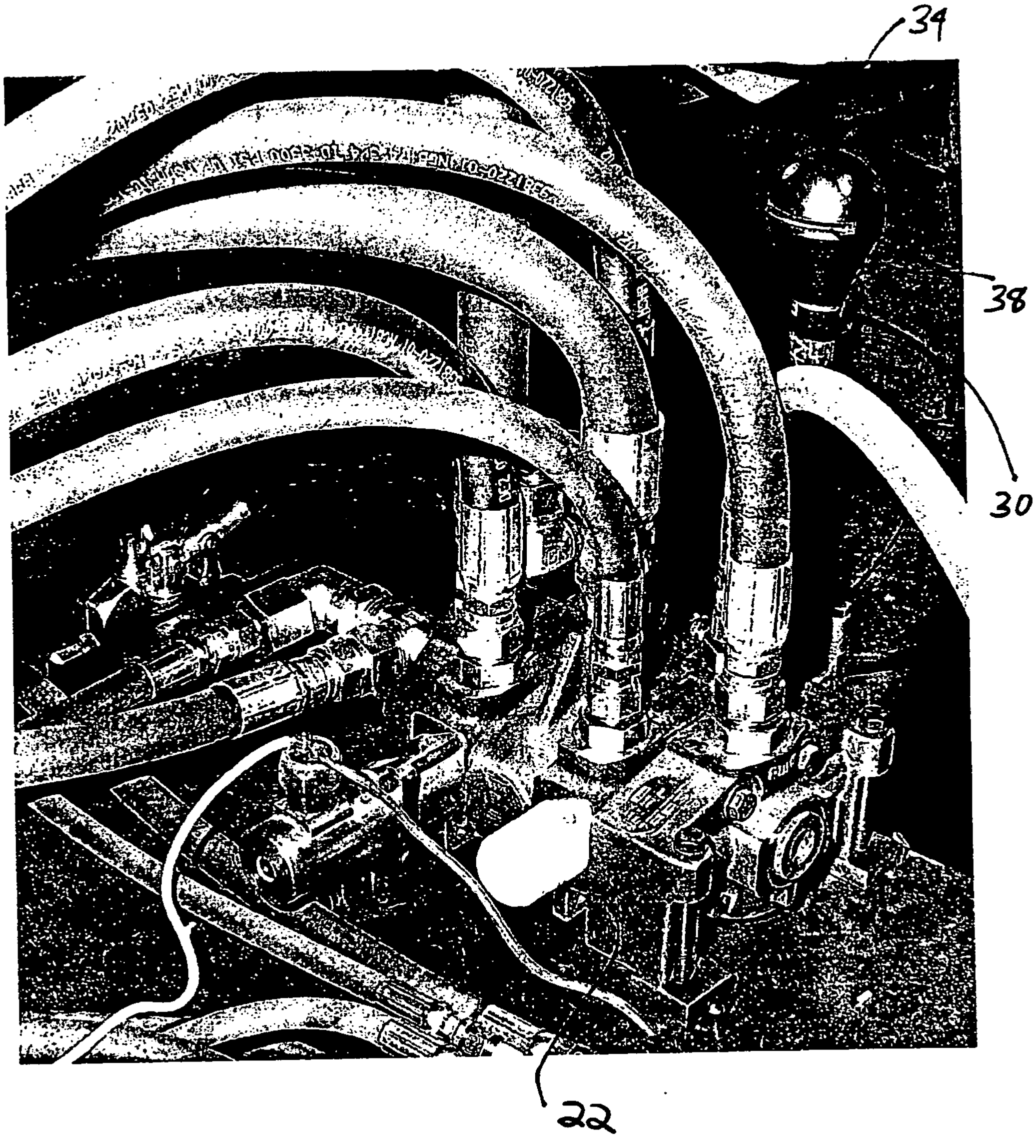


Fig. 6

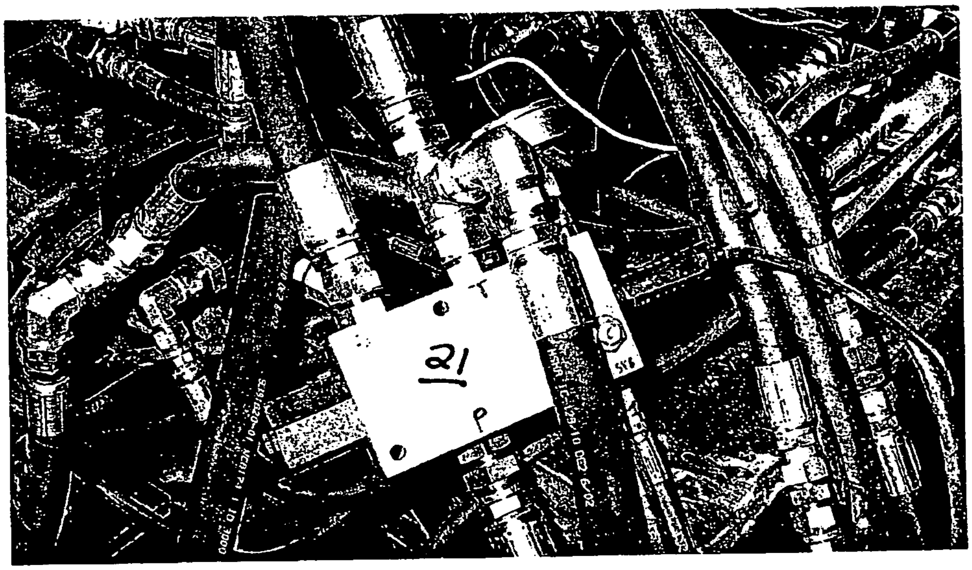


Fig. 7

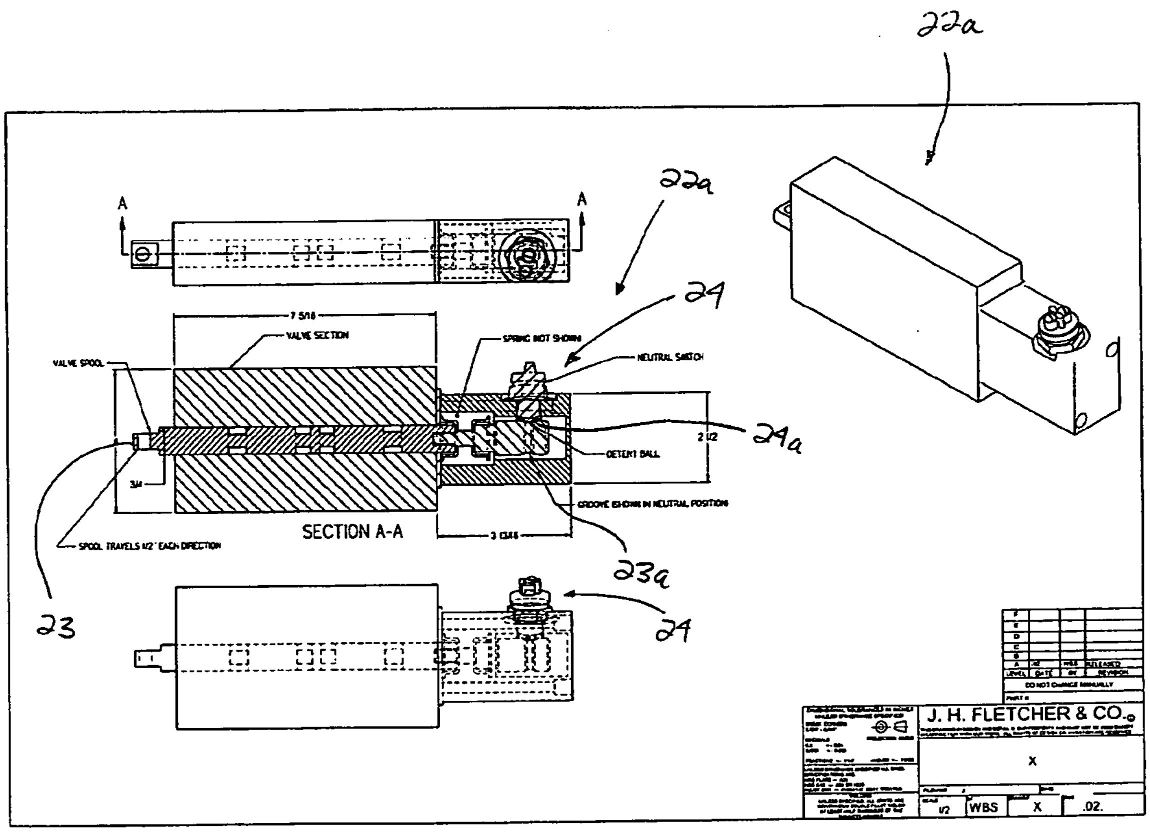
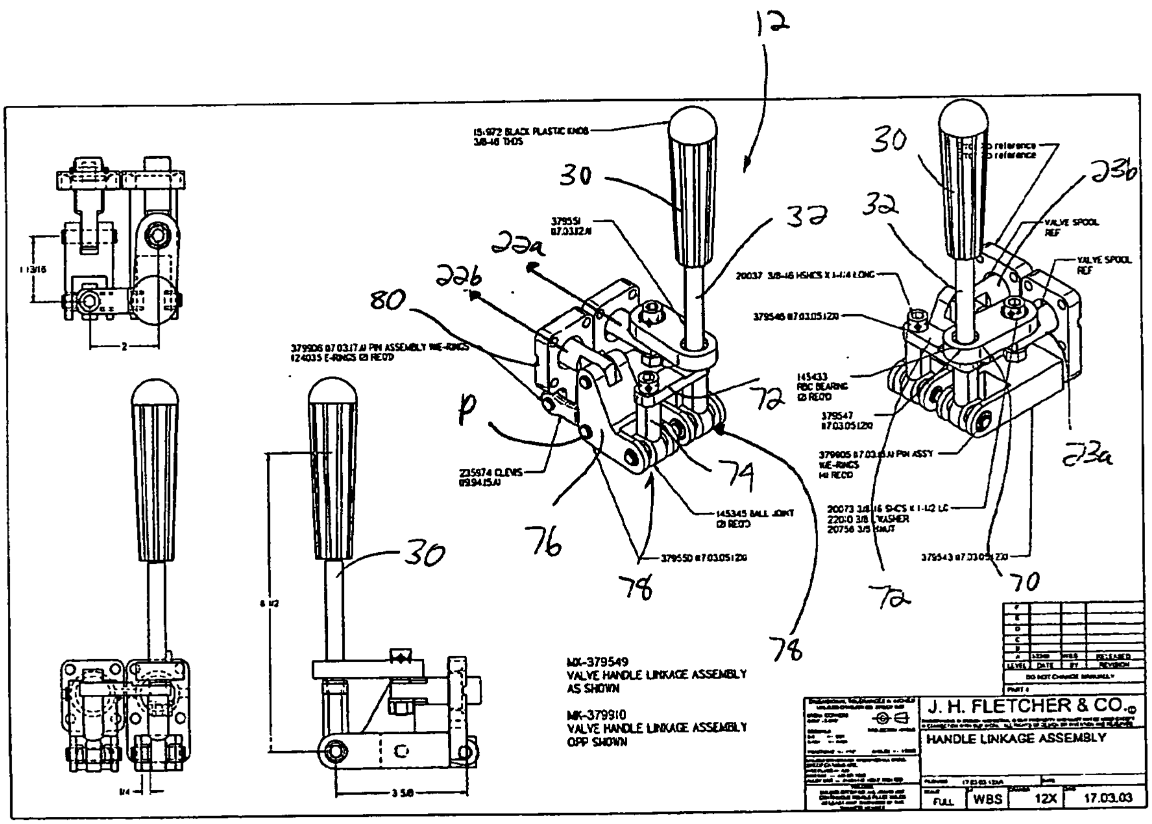

22a
A
A
22a
24
7 5/16
VALVE SECTION
VALVE SPOOL
SPRING NOT SHOWN
NEUTRAL SWITCH
24a
2 1/2
DETENT BALL
3/4
GROOVE SHOWN IN NEUTRAL POSITION
SECTION A-A
3 13/16
SPOOL TRAVELS 1/2" EACH DIRECTION
23a
23
24
DO NOT CHANGE MANUALLY
J. H. FLETCHER & CO.
X
1/2
WBS
X
.02.

Fig. 8



12
30
32
22a
22b
80
P
72
74
76
78
70
23b
23a
151972 BLACK PLASTIC KNOB 3/8-16 THDS
379551 87.03.12.N
20037 3/8-16 HSHCS X 1-1/4 LONG
379546 87.03.05.1ZO
145433 RBC BEARING (2) REQ'D
379547 87.03.05.1ZO
379905 87.03.13.N PIN ASSY W/E-RINGS (4) REQ'D
20073 3/8-16 SHCS X 1-1/2 LG
22010 3/8 WASHER
20756 3/8 NUT
379543 87.03.05.1ZO
379906 87.03.17.N PIN ASSEMBLY W/E-RINGS
124035 E-RINGS (2) REQ'D
235974 CLEVIS 89.94.15.N
145345 BALL JOINT (2) REQ'D
379550 87.03.05.1ZO
VALVE SPOOL REF
VALVE SPOOL REF
MK-379549
VALVE HANDLE LINKAGE ASSEMBLY
AS SHOWN
MK-379910
VALVE HANDLE LINKAGE ASSEMBLY
OPP SHOWN
J. H. FLETCHER & CO.
HANDLE LINKAGE ASSEMBLY
FULL
WBS
12X
17.03.03
DO NOT CHANGE MANUALLY
1 13/16
2
8 1/2
3 5/8
3/4

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US04/21928

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : E21B 47/00
US CL : 175/40,24,27,122,162
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 175/40,24,27,122,162

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,035,951 A (Mercer et al.) 14 March 200 (14.03.2000),Fig 1, col. 16, lines 37-45.	1,7/1,9,10/1,10/7/1,10/9,11-14,18,19
X	US 20020157870 A (Bischel et al.) 31 October 2002 (31.10.2002), Fig.1, paragraphs 0040 and 0064.	1,6,7/1,7/6,9,10/1,10/7/1,10/7/6,10/9/,11-14, 17-20
X	US 20010022238 A (Houwelingen et al.) 20 September 2001 (20.09.2001), Fig. 1, paragraphs 0008,0009, and 0105.	18-23

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search 07 December 2004 (07.12.2004)	Date of mailing of the international search report 04 MAY 2005
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer David J. Bagnell Telephone No. 703-308-1113

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(25) Filing Language: English

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(72) Inventors; and
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(74) Agents: SCHICKLI, Warren, D. et al.; King and Schickli, PLLC, 247 North Broadway, Lexington, KY 40507 (US).

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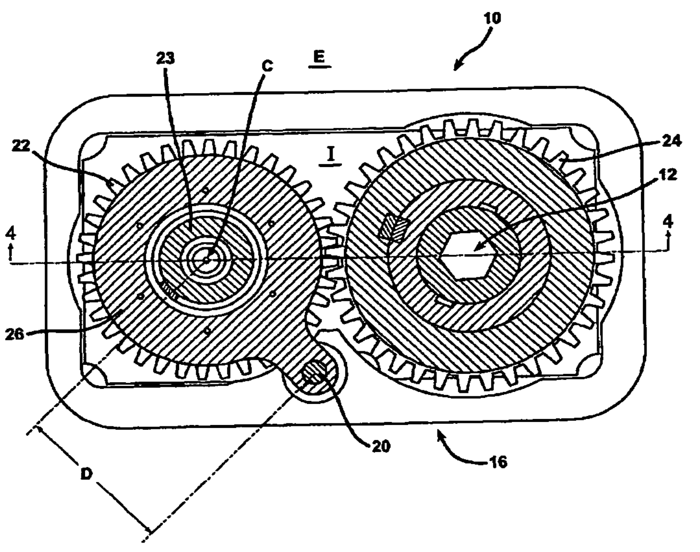
[Continued on next page]

(54) Title: INSTRUMENTED DRILL HEAD, RELATED DRILLING/BOLTING MACHINES, AND METHODS



(57) Abstract: In one aspect the invention comprises an instrumented drill head for intended use with a drilling machine including a drilling element, such as a drill bit. The drill head (10) includes a case (11) with a rotatable chuck (12) of the drilling element. A first sensor associated with the drill head (10) senses and generates an output signal representative of a first parameter of the drilling operation. A transmitter (60) wirelessly transmits a the signal to a receiver (64) associated with a controller (62). A roof bolting machine including the drill head and a resin inserter (100) is also discloses as are related methods of instrumented a drill head and drilling using an instrument drill head.

WO 2005/008017 A3

SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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